

Section 5

Plan Selection and Evaluation

This section documents the process by which the various plans for using clean dredged material from the Baltimore Harbor and Channels Federal navigation project to restore Poplar Island were developed and evaluated. The various plans were designed through the collaborative efforts of the multi-agency group, which consisted of USACE, MPA, MES, DNR, MDE, EPA, NMFS, and USFWS.

5.1 Site Selection Process

The process of selecting sites for this feasibility study proceeded through a number of iterative steps. Prior to initiation of this study, these steps were used to identify project sites. Once the project site was identified, various alternatives for the specific project site were developed. The following is a description of the process that was used to arrive at the alternatives evaluated in order to arrive at the recommended plan.

In July 1990, Maryland Governor William Donald Schaefer convened a task force to review dredged material management options. After examining a wide range of alternatives, the task force recommended that an effort be made to beneficially use dredged material. Poplar Island was identified as one of the sites at which this could be accomplished.

In May 1994, MES prepared a prefeasibility report (PFR) for the MPA on the Poplar Island Habitat Restoration Project. The purpose of the PFR was to assess the feasibility of utilizing dredged material for the restoration of Poplar Island, to produce a concept design for the project, to develop a plan for the next phase, and to formulate cost estimates on the major project components for use in comparison and budget planning activities.

During the study, a coastal engineering assessment was made, hydrographic and topographic surveys were performed, and geotechnical and archeological investigations were conducted. Based on the results of these analyses, three potential site footprints were developed that encompassed the 1847 footprint of Poplar Island. Footprint A, which would have enclosed the main body of the old footprint to the west of the four remnant islands, was the smallest with an estimated volume of 9 million cubic yards, covering an area of approximately 776 acres. Footprint B, which would have been the largest with an area of approximately 965 acres, would envelope over 90 percent of the old footprint and would exclude only the portions around Jefferson Island and to the north of Coaches Island. Footprint C would incorporate attributes of the larger and the smaller footprints. It would encompass the old footprint and would have almost the same acreage as Footprint B. However, Footprint C would provide an additional 5 percent capacity with an almost 10 percent reduction in dike. Since Footprint C had the largest capacity with 11 million cubic yards, avoided the oyster

bars, and excluded Coaches Island (which is privately owned), it became the PFR plan. Figures 5-1 through 5-3 show the various footprints developed during the PFR.

The PFR recommended using dikes and breakwaters to contain the dredged materials necessary for the wetlands vegetation and to protect the facility from the severe wave activity in that region of the Bay. Several types of dikes and dike materials were evaluated during the prefeasibility study. The recommendation of the study was that a low-crested stone dike with an impermeable clay core would be most appropriate. The study found that the dikes would need to be constructed to a height of 7 feet MLW along the eastern perimeter, 8 feet MLW along the western perimeter, and 9 feet MLW along the northern and southern perimeters. The PFR recommended that mechanical methods be used to construct the dikes, which would have side slopes of 2H:1V. Typical dike sections are shown in Figures 5-4 and 5-5.

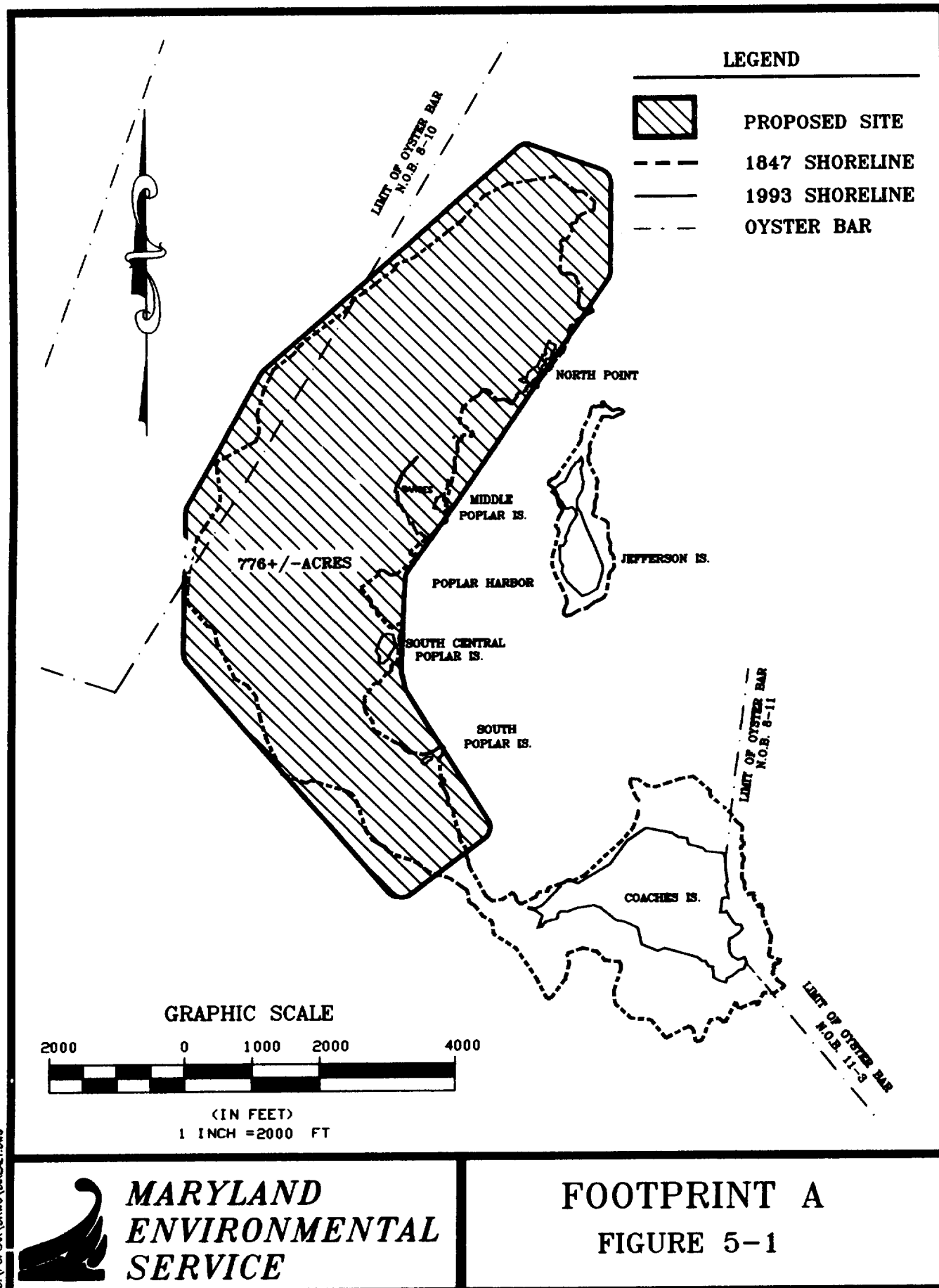
The total project would result in the creation of 1,000 acres of habitat of which 70 percent would be wetlands. Consequently, in order to establish habitat areas as early as possible, the report recommended constructing the project in phases, providing dredged material placement capacity of 3 to 4 million cubic yards per phase. The estimated construction cost for Footprint C, the PFR plan, was estimated to be approximately \$58 million excluding transportation costs. Based on the results of the PFR, it was recommended that a detailed feasibility study be initiated for the Poplar Island Restoration Project.

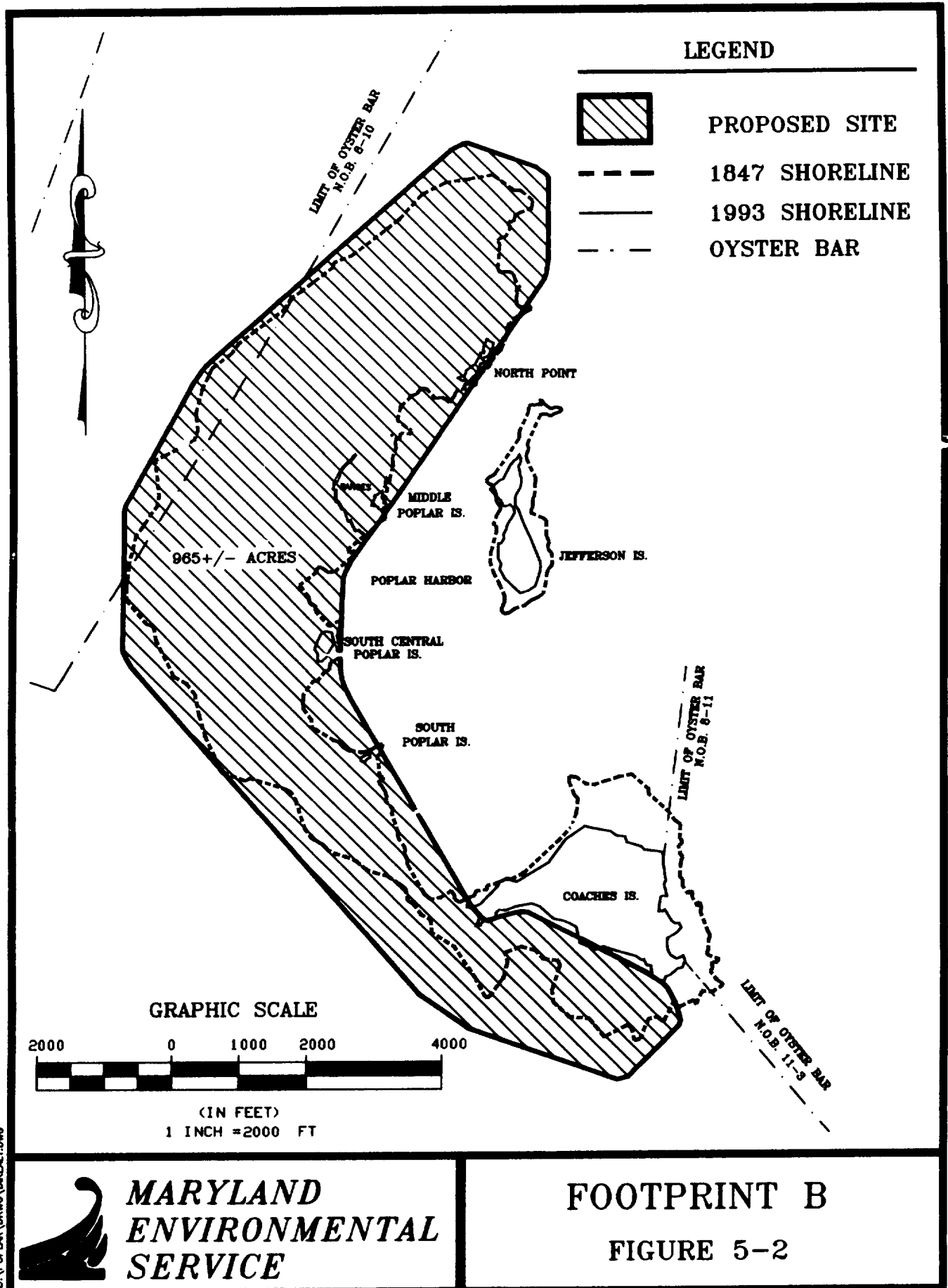
By letter dated May 3, 1994, the Maryland Department of Transportation (MDOT) requested that the USACE, in accordance with the provisions of Section 204 of the Water Resources Development Act of 1992, conduct a study to evaluate the feasibility of beneficially using dredged material from the Baltimore Harbor and Channels navigation project to restore Poplar Island. In response to that letter, the USACE prepared an initial appraisal report to evaluate the feasibility of the proposed project. Based upon a favorable review of the initial appraisal report, the current feasibility study was initiated.

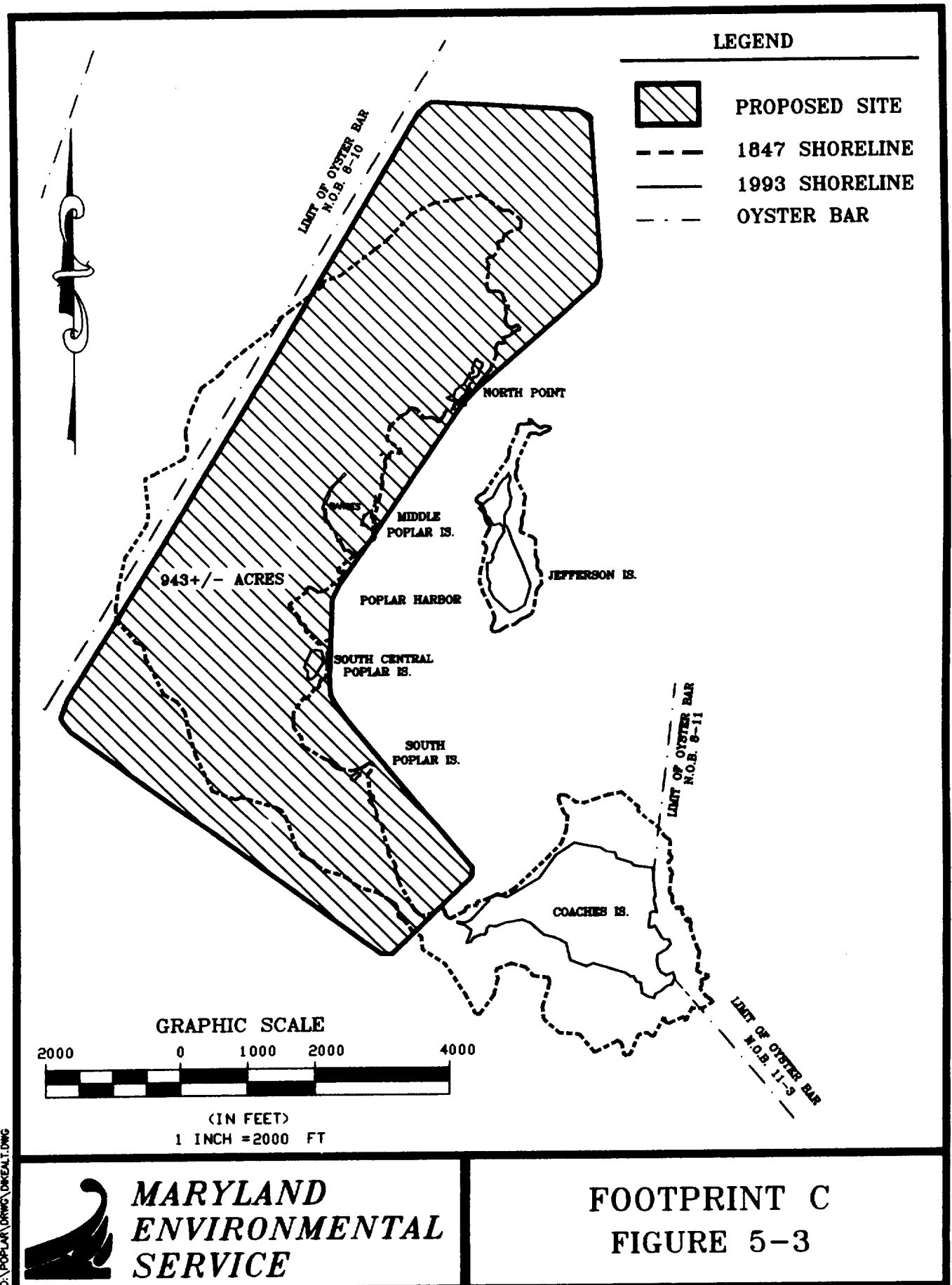
5.2 Base Plan

The USACE's base plan for navigation purposes is to accomplish the placement of dredged material associated with the construction or maintenance of navigation projects in the least costly manner that is consistent with sound engineering practice and that meets all applicable Federal environmental laws. This plan is referred to as the "base plan" and serves as a reference point for measuring the incremental costs of the ecosystem restoration project that are attributable to the environmental purpose if the ecosystem restoration project is not part of the base plan for the navigation purpose.

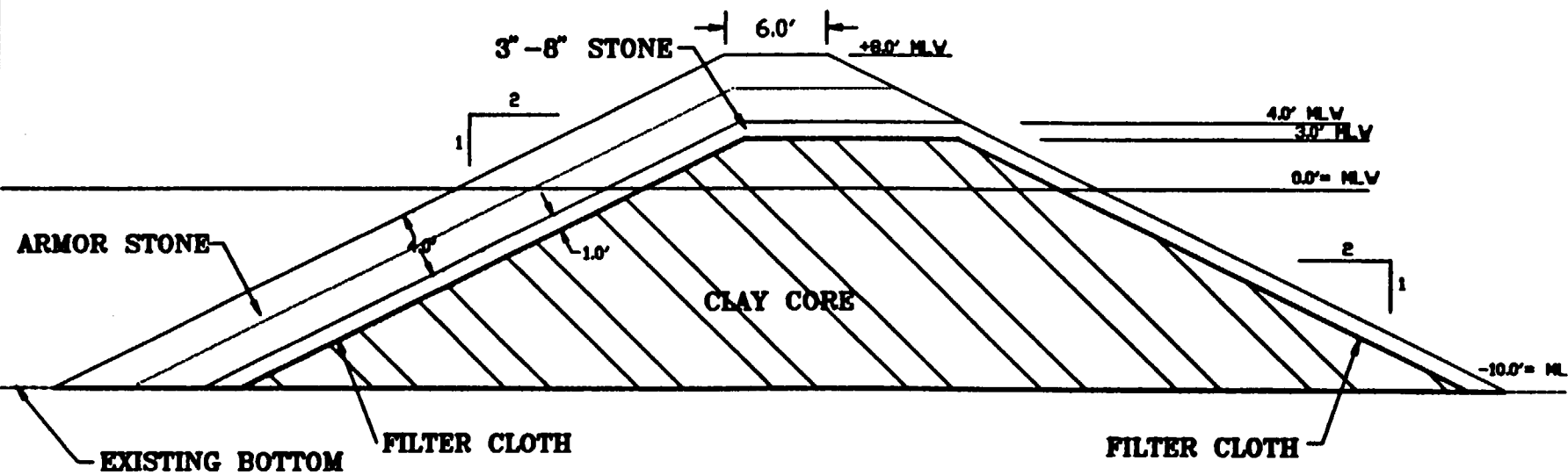
Material dredged from the Baltimore Harbor and Channels Federal navigation project is currently placed at HMI. A previously used upland site, CSX/Cox Creek, is being prepared to come on line in state fiscal year 1997, which begins in July 1996.







CHESAPEAKE BAY



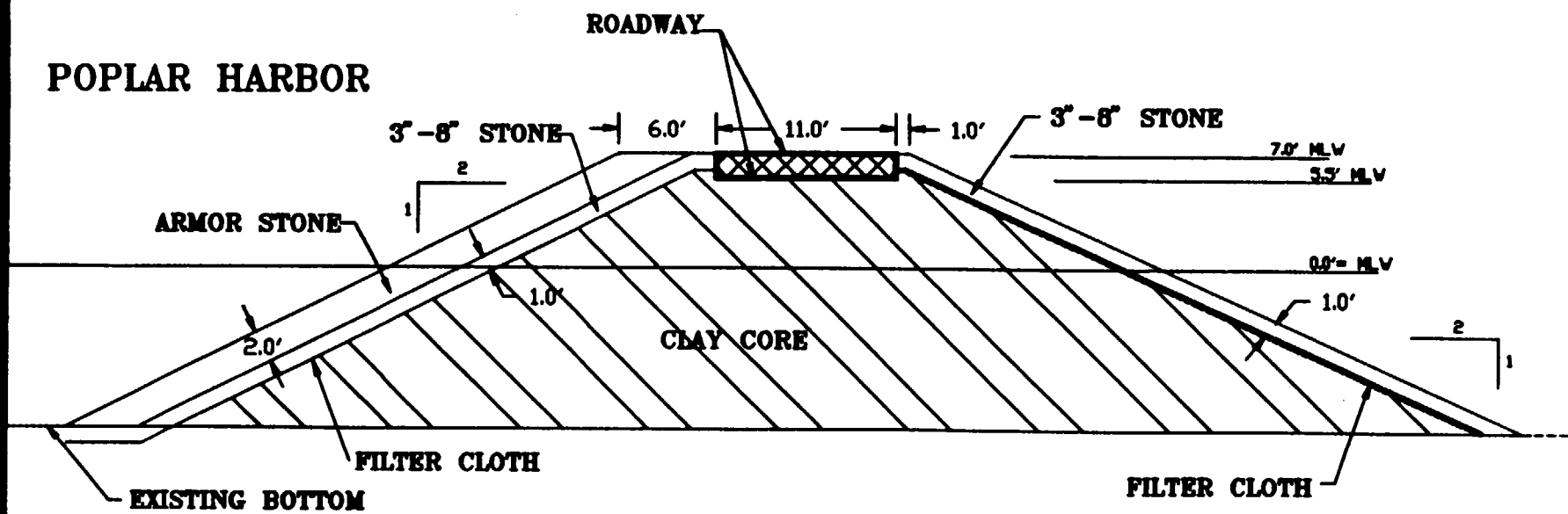
SCALE: 1"=10'

HIGH ENERGY DIKE SECTION

FIGURE 5-4

S-7

POPLAR HARBOR



SCALE: 1"=10'

LOW ENERGY DIKE SECTION

FIGURE 5-5

HMI currently has capacity in FY96 and 97 for about 4.1 mcy of dredged material. No material is scheduled to be placed in the site in FY98, but between FY99 and FY00, 2.4 mcy is scheduled to be placed at the site to cap and close it. The MPA has not yet designated what material will be used to cap the site. HMI is currently used for the placement of material from the Harbor channels and the Bay channels. The permit for HMI currently expires in the year 2000. The MPA expects to have the site off line by then. Even if the permit were to be modified, the site would be filled to capacity by then and would require structural improvements such as dike raising in order to handle more material. Such a move would likely meet with strong public opposition and require a modification to the existing permit, which limits the dike elevation to 28 ft and requires that the dikes be returned to the original 18-ft elevation.

The DNPOP has identified CSX/Cox Creek as a replacement for HMI to handle "contaminated" material. The site is currently expected to provide about 0.5 mcy of capacity per year, 6.0 mcy total, between state FY97 and 07. Due to the cost of developing a new containment facility and the lack of potential alternatives to this site, it is crucial that the site be restricted to only the Harbor's dredged materials. Even with this alternative, the capacity shortfall for Harbor channels will likely be about 0.2 mcy over the next 6 years and 4.0 mcy total over the next 20 years.

The currently used Pooles Island open water site has about 2.9 mcy of capacity over FY96, 97, and 98. After that, another option will be required. The Pooles Island site is currently dedicated to material dredged from the C&D approaches that are currently maintained by the USACE (Philadelphia District). While a severe problem for the MPA is identification of placement sites for material dredged from the C&D approach channels, the Philadelphia District is working with the MPA to identify solutions. Consequently, this site will not be discussed further in this report.

Hart-Miller Island was designated by the MPA and was included in the Baltimore Harbor and Channels 50-foot project Local Cooperation Agreement even though it is not considered the least-cost environmentally acceptable placement alternative [Base Plan] for clean dredged material. It is the only placement site available for maintenance material at this time.

The base plan for dredged material from the following reaches of the Baltimore Harbor and Channels Project - the Craighill Entrance Channel, the Craighill Channel, the Craighill Angle, the Craighill Upper Range, the Cutoff Angle, the Brewerton Channel Eastern Extension, the Tolchester Channel, and the Swan Point Channel - is placement at the Deep Trough. This is not to say that placing dredged material in the Deep Trough results in the least environmental impacts, but rather, based on existing information, that this alternative is the least costly and is unlikely to have unacceptable impacts. Dredged material from these channels has been placed in open waters of the Chesapeake Bay without unacceptable impacts in the past.

Dredged material is placed at open water sites in the upper and lower reaches of the Bay and in near coastal waters off the mouth of the Chesapeake. The impacts of the placement activities have been determined to be acceptable. By extension, even though the ecology of the region is distinct from these other regions, we cannot assume that placement of dredged material at an open water site in the middle reaches of the Bay would be unacceptable.

The Baltimore District is currently conducting a Dredged Material Management Plan (DMMP) Study for the Baltimore Harbor and Channels Project. This effort is expected to reaffirm that placement of dredged material from the approach channels in the central Bay at the Deep Trough site is the Base Plan for cost sharing. Capacity in the Deep Trough could be more than 100 million cubic yards, which would more than necessary to satisfy placement needs for sediment from the Bay channels for the next 50 years.

The Deep Trough is a deep water ravine in the central Bay adjacent to Kent Island. Bottom waters in the Deep Trough become anoxic every summer and organisms in the sediments or in the water column near the bottom are either killed or forced from the area. Some recolonization is expected when oxygenated waters return, but overall richness of the habitat is greatly diminished by the annual kills. In the winter, the side slopes and the deeper waters of the Bay may provide refugia for some species during the coldest periods, but the channels that are dredged, especially the margins of the channels, also provides refugia for many of the same species.

There have been several studies of the Deep Trough as a potential placement site. Investigations conducted by the MPA, DNR, and MES and coordinated with MDE, concluded that placement of dredged material at the site would have no significant direct or indirect ecological impact or impact on water quality. In 1990, MPA proposed to place 2.2 million cubic yards of sediment dredged from the Craighill Channel in a portion of the Deep Trough as a demonstration project. The specific proposal called for pumping the dredged material into the anaerobic zone (at a depth of at least -60 feet MLLW) during the summer months.

In order to evaluate the Deep Trough placement site, literature reviews, water quality sampling, sediment sampling, biological surveys, and modeling exercises were conducted to determine the impacts to the following:

- Hydrodynamics
- Biological Resources
- Commercial/Sport Fisheries
- Nutrient loading
- Toxic loading
- Sediment transport
- Cultural resources
- Recreation

The results of these studies are summarized as follows:

- The Deep Trough is an area of net deposition and, therefore, is not subjected to forces of erosion or scouring.

- Anoxic (i.e., without oxygen) conditions occur in the proposed placement area each summer, generally from 15 June to 15 September, although the magnitude, timing, and duration vary.
- Communities of benthic (i.e., bottom-dwelling) organisms are completely eliminated during summer anoxia.
- Benthic communities do not recolonize to a level that is sufficient to support bottom-feeding organisms during oxygenated periods of the year.
- Decreasing the bottom depths by 3 to 6 feet will not affect the temperature regime of the area.
- Slightly uneven bottom topography (i.e., clumping) is expected to result from the test because the dredged material was predominantly sand.
- Anoxic conditions in the Deep Trough may enhance the release of nutrients in sediments removed from an oxygenated environment.

Based on the results of the site investigation and coordination with the other resource agencies, and drawing on the results of monitoring placement of dredged material at numerous other aquatic sites, it was determined that the Deep Trough was an acceptable placement site for clean dredged material. However, the MPA had proposed pumping the dredged material out of the barges at the site and shunting the material to -60 feet MLLW. This proposed timing and placement method was viewed by the EPA and the District as exacerbating potential nutrient release from the dredged material¹ and potentially contributing to low DO conditions in the Deep Trough. The District and other resource agencies held that the proposed placement should be limited to mechanically dredged sediment, released from split hull scows, at times when anoxic conditions did not exist in the Deep Trough.

The draft environmental assessment recommended that a formal "finding of no significant impact" (FONSI) be prepared for the proposed placement. However, before the final environmental assessment [incorporating the alternate placement methods recommended by the

¹ Under oxygen deprived conditions, the naturally occurring sulfur in the sediment dredged from the Bay has its oxygen atoms stripped away, converting it from sulfates to sulfides. Hydrogen sulfide is a strong reducing agent which reacts with the metal compounds in a sediment (e.g., ferrous oxides are reduced to ferrous sulfides). The nutrients which have mineralized with the metallic compounds in the sediment are released by this action. Not all the nutrients so affected make it into the water column and the process is reversed when the water column returns to aerobic conditions. However, if the dredged material is introduced into the anoxic/sulfidic condition as a slurry (the proposal called for pumping the slurried material to a depth of -60 feet MLLW), there is a very rapid and complete transfer of nutrients into the water phase of the slurry (Stigall 1995).

District and other resource agencies] and the FONSI could be prepared and released, the proposal to use the site was withdrawn by the MPA.

The District will continue to utilize the remaining capacity at Hart-Miller Island. The Deep Trough will be the base plan for all project sediments (that have been determined to be suitable for open water placement in accordance with Section 404 Guidelines) from the Craighill Entrance Channel, the Craighill Channel, the Craighill Angle, the Craighill Upper Range, the Cutoff Angle, the Brewerton Channel Eastern Extension, the Tolchester Channel, and the Swan Point Channel. The Federal Operation and Maintenance (O&M) Program will be responsible for the costs that normally would be associated with channel maintenance and for the transport and placement of the dredged material at the Deep Trough. The incremental cost of using the Poplar Island site would be the additional transportation costs; the dredged material placement costs; the construction costs of the habitat restoration project; dredged material dewatering, shaping, and planting; and site O&M. The transport distance from the Deep Trough to Poplar Island is about 10.5 miles, one way. The incremental transportation and off-loading costs are approximately \$151.2 million. A summary of the anticipated costs of placement at the Deep Trough is shown in Table 5-1.

5.3 Poplar Island Configuration Assessment

At the onset of the feasibility study, an extensive field investigation study was undertaken. Hydrographic surveys, geotechnical subsurface investigations, archeological investigations, and hydrodynamic studies were performed to establish the design parameters. These parameters were then utilized to develop various alternative dike alignments that were then evaluated from an economic, technical, and environmental perspective.

5.3.1 Dike Alignment Alternatives

Beginning with the alignment developed in the PFR plan, three additional alternative alignments were developed for consideration. The four alignments are shown in Figure 5-6. Alignment Number One is a variation of the PFR plan. It was developed when geotechnical subsurface investigations revealed that the northern end of the site needed to be avoided due to an area of soft foundation materials. Figure 5-7 shows the location of these soft foundation materials. The northwestern and eastern portions of the dike are the same for the PFR plan and for Alignment Number One. Unlike the PFR plan, Alignment Number One ties into the western side of Coaches Island. Alignment Number One has a nominal site area of 820 acres (Figure 5-7).

Alignment Number 2 is an extension of Alignment Number 1 to the south and east and fronts on the southern shoreline of Coaches Island. The southeastern and southern segments of the perimeter dike generally follow the 8-foot MLLW contour. This alignment was developed upon the realization that the water depths in this area would be suitable for creating additional wetland habitat, thereby potentially increasing the project's environmental outputs and placement capacity. This alignment is the largest, with a nominal site area of 1,340 acres.

**TABLE 5-1
BASE PLAN COSTS**

	1st year dredging	2nd year dredging	3rd year dredging	4th year dredging	5th year dredging	6th year dredging	7th year dredging	8th year dredging	9th year dredging
Mob/Demob & prep	508,000	508,000	508,000	508,000	508,000	508,000	508,000	508,000	508,000
Mechanical dredging	5,359,000	5,359,000	5,359,000	5,359,000	5,359,000	5,359,000	5,359,000	5,359,000	5,359,000
Engineering, planning, and design	111,000	111,000	111,000	111,000	111,000	111,000	111,000	111,000	111,000
Construction Management	245,000	245,000	245,000	245,000	245,000	245,000	245,000	245,000	245,000
Total	6,223,000	6,223,000	6,223,000	6,223,000	6,223,000	6,223,000	6,223,000	6,223,000	6,223,000

	10th year dredging	11th year dredging	12th year dredging	13th year dredging	14th year dredging	15th year dredging	16th year dredging	17th year dredging	18th year dredging
Mob/Demob & prep	508,000	508,000	508,000	508,000	513,000	513,000	517,000	517,000	522,000
Mechanical dredging	5,359,000	5,359,000	5,359,000	5,359,000	5,406,000	5,406,000	5,452,000	5,452,000	5,499,000
Engineering, planning, and design	111,000	111,000	111,000	111,000	111,000	111,000	112,000	112,000	113,000
Construction Management	245,000	245,000	245,000	245,000	247,000	247,000	249,000	249,000	251,000
Total	6,223,000	6,223,000	6,223,000	6,223,000	6,277,000	6,277,000	6,331,000	6,331,000	6,385,000

	19th year dredging	20th year dredging	21st year dredging	22nd year dredging	23rd year dredging	24th year dredging	TOTAL
Mob/Demob & prep	522,000	526,000	526,000	530,000	530,000	530,000	12,350,000
Mechanical dredging	5,499,000	5,545,000	5,545,000	5,592,000	5,592,000	5,592,000	130,247,000
Engineering, planning, and design	113,000	114,000	114,000	115,000	115,000	115,000	2,688,000
Construction Management	251,000	253,000	253,000	256,000	256,000	256,000	5,953,000
Total	6,385,000	6,439,000	6,439,000	6,493,000	6,493,000	6,493,000	151,241,000

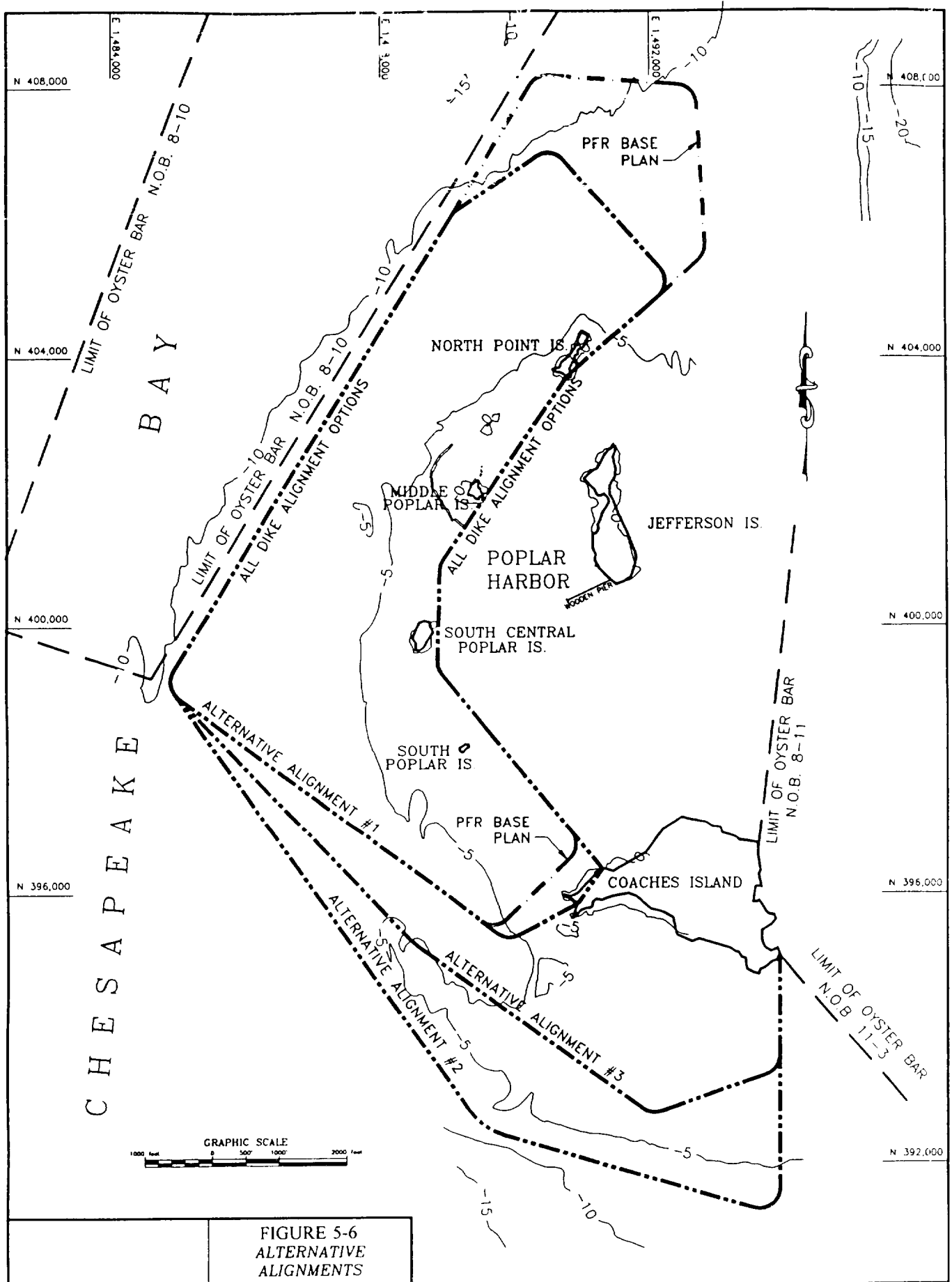


FIGURE 5-6
ALTERNATIVE
ALIGNMENTS

5-14

- LEGEND**
- 5 — EUSTINE CONTOUR
 - 1983 SHORELINE
 - - - - - EASTERLY PERIMETER DUNE
 - - - - - WESTERLY PERIMETER DUNE
 - - - - - ALIGNMENT NO. 1
 - - - - - ALIGNMENT NO. 2
 - - - - - ALIGNMENT NO. 3
 - 0/5 0 = THICKNESS OF OVERBURDEN
 - 6 = THICKNESS OF SAND
 - BORINGS

GENERAL NOTES:

1. VERTICAL DATUM IS MLLW FOR THE '66 TO '78 TIDAL EPOCH.
2. HORIZONTAL DATUM IS THE NORTH AMERICAN 1983 DATUM, MARYLAND STATE PLANE COORDINATE SYSTEM.

NOTES:

1. CONTOURS BASED ON SURVEY DATED SEPT. 1983 AND NOV. 1994.

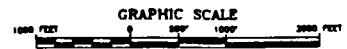
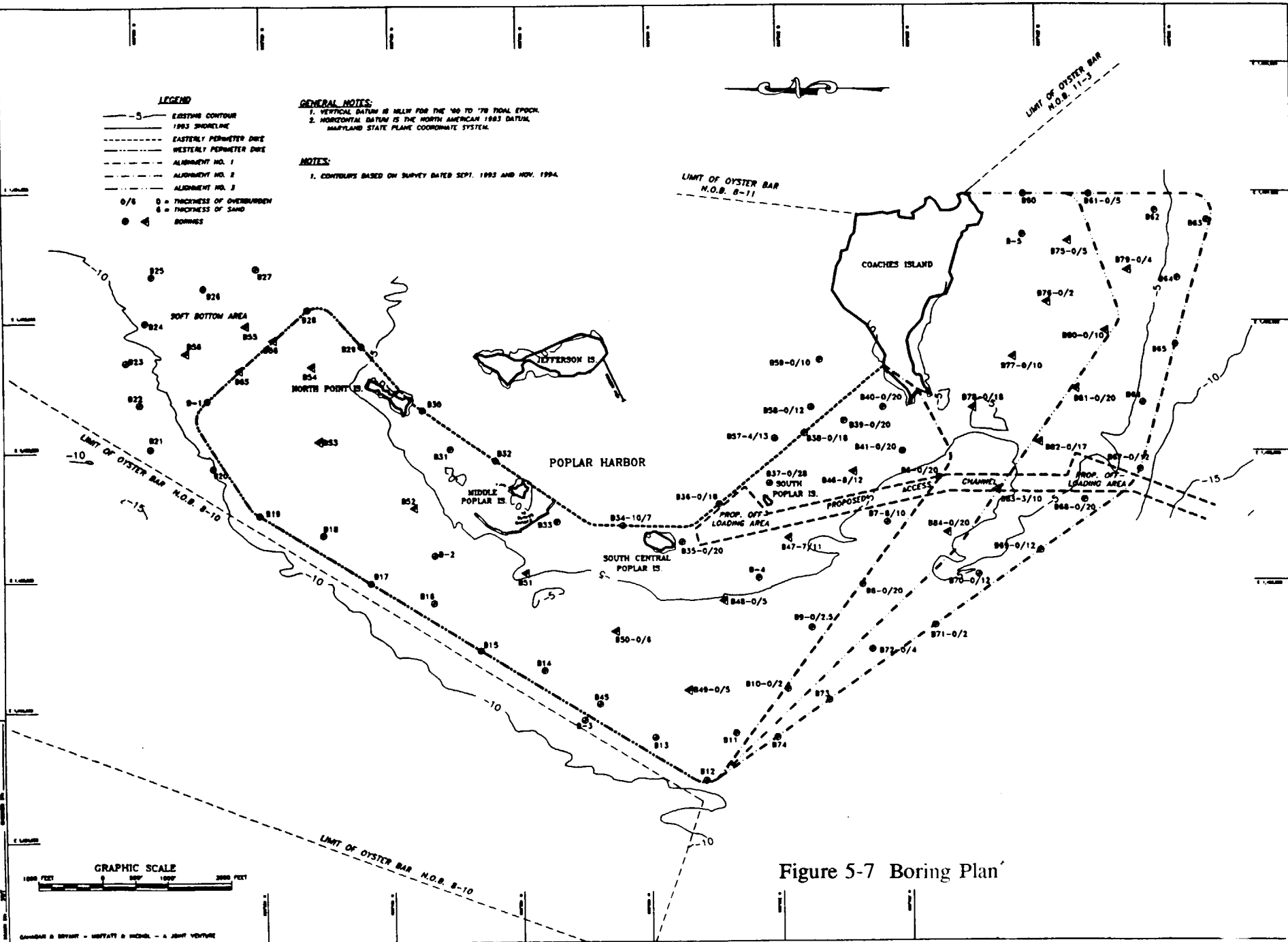


Figure 5-7 Boring Plan

Alignment Number 3 was selected as an intermediate alignment alternative between the smallest and largest alignment alternatives. It has an area of 1,110 acres, which just exceeds the average areas of the other two alignment alternatives. It also fronts on the southern shoreline of Coaches Island and would also allow more wetland habitat than the PFR plan alignment or Alignment Number One. The PFR recommended constructing the containment dikes of clay because preliminary borings indicated that the clay was the only material available in sufficient quantity on-site. However, geotechnical investigations conducted for the feasibility study disclosed that a sufficient quantity of fine sand, which is preferable to clay, is also available for construction of the dikes. Since clay dikes could not have been constructed to 2H:1V slopes under water, and settlement of clay under the immediate placement of armor stone would have presented costly problems, the dike cores will be constructed with the fine sands located within the project area.

5.3.2 Wetland/Upland Ratios

In addition to the various alternative alignments presented above, several different wetland/upland ratios were also considered. Because the project objective is to provide the most productive fish and wildlife habitat possible, restoring a mix and interspersed of habitat types will recreate the type of island ecosystem endemic to the middle, eastern portion of Chesapeake Bay. Three different wetland/upland ratios were examined: 50-percent wetland/50-percent upland, 70-percent wetland/30-percent upland, and 100-percent wetland. Since the project purpose is to restore wetland and island habitat and realizing that the various resource agencies would not support a site entirely composed of uplands, the 100-percent upland ratio was not considered. The 100-percent wetland option was included in the analysis strictly for comparison purposes since all of the agencies involved realized that it would not be cost effective to develop a dredged material placement site that had no uplands. Also, it was recognized that to recreate the productive remote island habitat that is becoming so scarce in the Bay, some upland component to the project was necessary. This is because migratory waterbirds and shorebirds require the uplands for nesting and other life requirements. In addition to balancing the wetland/upland ratios, upland elevations of 10 feet and 20 feet were proposed for each of the plans.

5.3.3 Selection of the Agency-Supported Plan

At a Working Group meeting on 29 June 1995, the various alternative alignments were presented for the resource and regulatory agencies to review. The group was asked to identify the alignment(s) and the wetland/upland ratio(s) they would be able to support in a final design. Prior to the meeting, the agencies had been provided with a summary table of the alternatives and costs for the various plans (Table 5-2).

The MPA presented a comparison of the site capacity and habitat percentages associated with the various options. The MPA's recommendation was for Alternative Alignment Number 2 (1,340 acres), with 50 percent wetlands and with an upland elevation of 20 feet. The MPA's rationale for recommending this plan was that it had the most economical initial construction

TABLE 5-2
Alternatives Matrix

Align- ment No.	Site Area (Acre)	Percent Tidal Wetlands	Upland Elevation (ft)	Site Capacity (mcy)	Site Operational Life (yr)	Initial Construction Cost		Total Site Development Cost	
						(\$mil)	(\$/cy)	(\$mil)	(\$/cy)
1	820	50%	10	18.8	11.1	\$40.4	\$2.15	\$78.0	\$4.15
1	820	70%	10	14.7	8.6	\$41.6	\$2.83	\$74.9	\$5.10
1	820	100%	--	9.9	5.8	\$33.9	\$3.42	\$59.1	\$5.97
3	1110	50%	10	24.5	14.4	\$49.6	\$2.02	\$104.7	\$4.27
3	1110	70%	10	20.0	11.8	\$50.5	\$2.53	\$100.0	\$5.00
3	1110	100%	--	13.0	7.6	\$40.7	\$3.13	\$76.3	\$5.87
2	1340	50%	10	30.5	17.9	\$54.1	\$1.77	\$124.7	\$4.09
2	1340	70%	10	24.1	14.2	\$55.0	\$2.28	\$116.9	\$4.85
2	1340	100%	--	16.0	9.4	\$44.7	\$2.79	\$89.4	\$5.59
1	820	50%	20	28.7	16.9	\$40.4	\$1.41	\$88.6	\$3.09
1	820	70%	20	20.6	12.2	\$41.6	\$2.02	\$81.6	\$3.96
3	1110	50%	20	37.9	22.3	\$49.6	\$1.31	\$122.1	\$3.22
3	1110	70%	20	28.0	16.5	\$50.5	\$1.80	\$110.8	\$3.96
2	1340	50%	20	46.7	27.4	\$54.1	\$1.16	\$147.3	\$3.15
2	1340	70%	20	33.8	19.9	\$55.0	\$1.63	\$131.0	\$3.88

Source: GBA

Note that the costs shown in the table are estimated mid-1995 construction and site development costs. The estimated initial site construction costs are more tangible than the other site development costs. No present value of future costs are estimated. The future costs of channel maintenance (dredging, transport and placement) are not included in the above values.

cost and would result in the development of approximately the same number of acres of wetlands as the PFR plan (670 acres). Members of the Working Group pointed out to the MPA that although that was the case, the group was less interested in obtaining a certain number of wetland acres and more interested in having a habitat restoration project that was comprised of a certain percentage (70 percent) of wetland habitat.

The MPA responded that while it supports the habitat issues, it is most important to produce a project that economically provides dredged material capacity. Given the current and anticipated future Federal and state funding constraints, it is important to recommend an alternative that balances capacity and costs.

Initially, the majority of the Working Group members were more in favor of supporting an alternative that would provide 70 percent wetland habitat regardless of the upland elevation. DNR presented some preliminary information that they had developed on the change in primary production of phytoplankton, benthic organisms, and fisheries at the site for different options. According to the calculations presented, all of the wetland options resulted in a net loss of primary productivity. Consequently, DNR's recommendation was for Alternative Alignment Number 1 (820 acres) with 70 percent wetlands to minimize the loss.

MDE's recommendation was for Alternative Alignment Number 2 with 50 percent wetlands. The rationale for this recommendation was that the efforts associated with bringing a dredged material site on-line are tremendous. Since a site has been identified that everyone supports, action should be taken to maximize its use and minimize the number of additional sites that must be developed. MDE also pointed out in response to DNR's productivity analysis that the wetlands should increase the productivity of other species and that the uplands habitat also would provide a contribution that needed to be taken into account.

EPA agreed with MDE's logic and pointed out that, realistically speaking, Federal funds are more likely to be provided for those projects that have the longest operational life (i.e. those projects that will be used for the longest period of time). It was EPA's feeling that, in order for Poplar Island to successfully compete for dwindling Federal funds, the project must provide the MPA with a long-term solution to the dredged material placement problem.

NMFS, NBS, and USFWS all supported Alternative Alignment Number 3 (1,110 acres) with 70 percent wetlands. Both NMFS and NBS said that it was always known that there would be tradeoffs associated with this project. Additional loss of bottom habitat over the PFR plan, while of concern, is supportable in light of the very real economic and capacity issues. It was the feeling of these agencies that this option presented an acceptable tradeoff, since it provided the best balance of gains and losses.

Additional discussions about how the operational life might influence the project's possibility of obtaining funding were held. DNR expressed the opinion that Alternative Alignment Number 3 would be better than no project at all. MPA acknowledged that Alternative Alignment Number 3 could provide a viable project, but that from an economics point of

view, it would need to contain 50 percent wetlands instead of 70 percent. DNR, USFWS, and NMFS agreed to support the 50 percent wetlands option if (1) 80 percent of the wetlands would be designated as low marsh, and (2) stone habitat enhancement structures were incorporated into the design to offset the habitat's being lost as a result of the displacement of the existing snags that surround the remnant islands. The other agencies (USFWS and NMFS) represented at the meeting agreed with these conditions, and this became the agency-supported plan.

The recommendation of the Working Group to make the agency-supported plan Alternative Alignment Number 3 with an upland elevation of 20 feet and with 50 percent wetland habitat, 80 percent of which would be low marsh, and with a number of stone habitat enhancement structures to offset the habitat's being lost, was presented to the Management Committee of the DNPOP on August 2, 1995. The Management Committee voted to accept the recommendation of the Working Group.

5.4 Environmental Impacts

One requirement of the NEPA process is to evaluate the potential impacts of a project to area resources. The following section analyzes the impacts of the reconstruction of Poplar Island on the various resources identified previously in Section 3. The impacts of three alternatives (Deep Trough, Other Smaller Sites, and No Action) are summarized in Section 2.2.2.

5.4.1 Setting

High rates of erosion have reduced Poplar Island from 1,000 acres to approximately 79 acres during the past 150 years. Over the long term, this project will restore approximately 1,100 acres to Poplar Island, changing the physiographic features of the site from a fragmented series of islands to one intact, protected island environment. When the entire Poplar Island restoration project is complete and the dikes are armored, movement of sand from the dikes should be negligible.

The island will be comprised of approximately 555 acres each of upland and wetland habitat. Because elevations on the island will range from -0.6 up to 20 feet MLLW, it is anticipated that wetland- and upland-type soils will develop over time to support a variety of habitats. These soils will develop as a top layer over the base of clean, fine-grained silt and clay materials dredged from Chesapeake Bay channels (EA 1995f) placed at the site.

Although approximately 1000 acres of shallow water habitat will be lost due to dike construction, approximately 300 acres of the restored island will be comprised of inter-tidal habitat. Therefore, the net loss of shallow water habitat in the project area will be 700-800 acres.

Short-term (construction phase) impacts are expected to some resources, particularly aquatic organisms within the proposed dike alignment. The restoration of a stable island with the development of associated habitats is expected to be a long-term beneficial change to the region.

5.4.2 Physiography, Geology, and Soils

Construction of the project will have primarily minimal and short-term impacts on environmental resources in the project area. On-site borrow areas located in the south-central project area will serve as the source area for sand required to construct the initial interior dikes and the core of initial perimeter dikes (Figure 5-8). Other materials will be transported to the site from off-site quarries. Approximately 2.6 million cubic yards of material occupying approximately 250 acres of bottom area will be dredged from the borrow areas. Sand thickness in these areas ranges from approximately 4 to 20+ feet (E2SI 1995). The residual substrate in the depression formed from the removal of sand materials will consist primarily of fine sands transported from and consistent with adjacent bottom areas. The potential impacts associated with turbidity and water quality from the movement of sediment after placement of these materials are discussed in Section 5.4.5. Armor stone needed to protect the slopes of the exposed dike sections (Figure 5-9) will originate from off-site locations. Quarry run stone will be required for the core of the rock toe dike.

A channel will be dredged to provide access to the south end of the project site. During construction, an 8,700-foot long by 300 to 400-foot wide access channel will be dredged to a depth of approximately 25 feet to facilitate project operations. The access channel will serve as a source of sand used as borrow material for dike construction. In addition to providing equipment access, the 25-foot dredging depth will reduce the need for frequent dredging caused by siltation. Approximately 2.0 million cubic yards of primarily sandy material will be dredged from this area and used for dike construction (Figure 5-10).

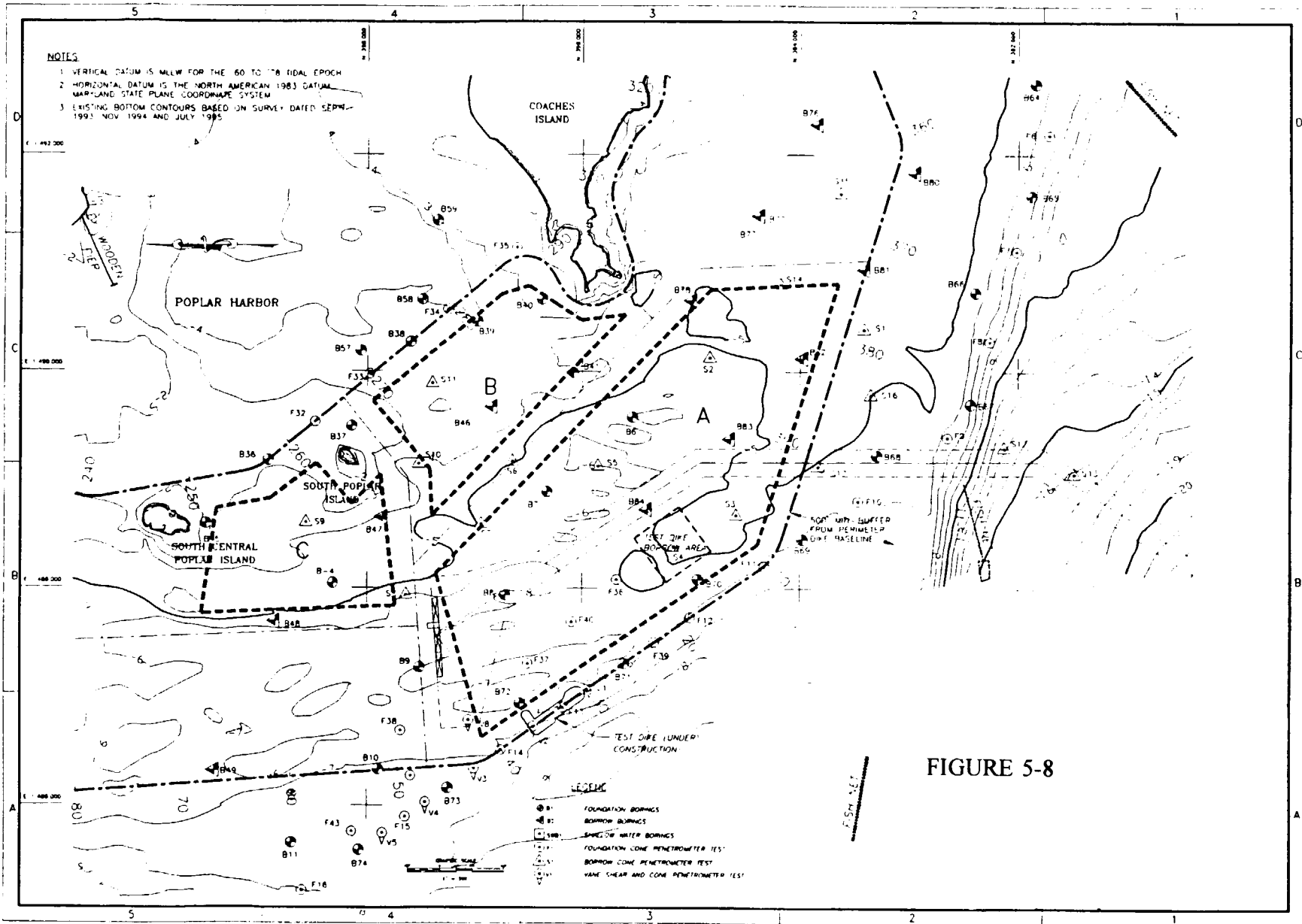
5.4.3 Hydrology and Hydrodynamics

5.4.3.a Hydrodynamics. It is anticipated that the proposed restoration of Poplar Island will have little effect on natural circulation or sedimentation patterns. Overall tidal currents in the vicinity of Poplar Island are relatively weak, and the area occupied by the restored island is insignificant when compared to the wide expanse of the Chesapeake Bay. Moreover, the proposed project tends to return the Poplar Island area to a condition similar to that of its historical past.

Hydrodynamic modeling was used to support this judgement and to assess trends relative to preconstruction and postconstruction conditions within the project area. Models of tidal hydrodynamics, constituent transport, and sedimentation were developed to assess relative changes to tidal flows, residence times, and sedimentation in the vicinity of Poplar Island.

Although modeling was not verified to the extent normally done in high-current regimes, it is believed that the model was sufficient to support the original conclusion that project impacts will be minimal.

Figures 5-11 and 5-12 present the peak flood-flow velocity vectors and velocity contours in the vicinity of Poplar Island for the final dike alignment. Figures 5-13 and 5-14 present the same information for peak ebb flow. Several hydrodynamic impacts will result from restoration of the island. First, the waters presently flowing through the island complex will



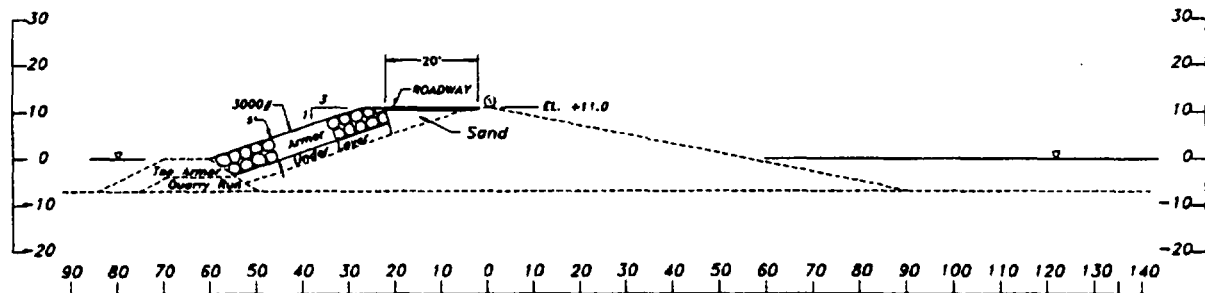
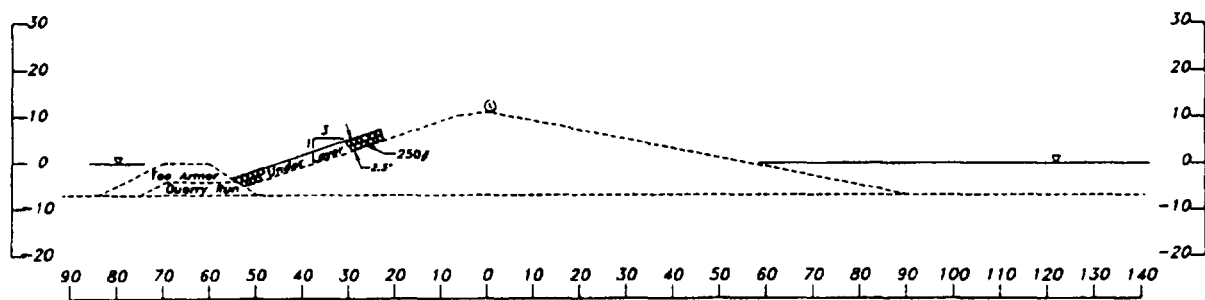
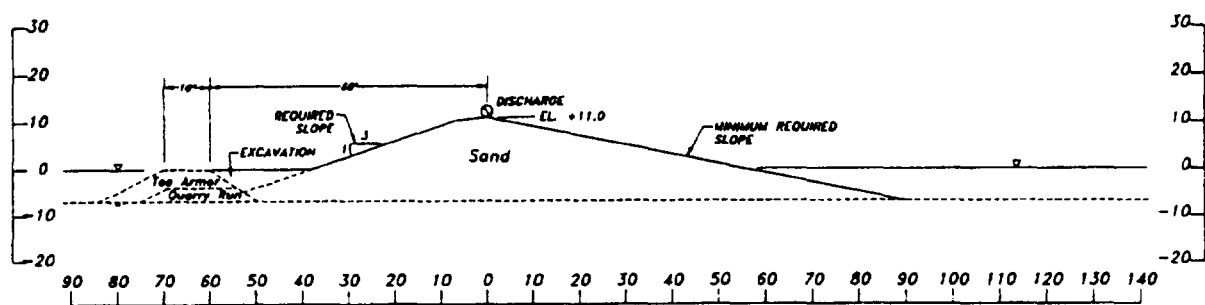
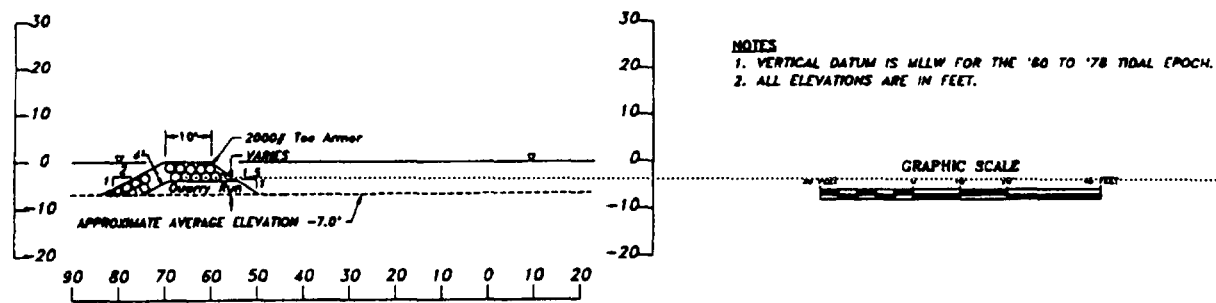


Figure 5-9. Western perimeter dike construction staging.

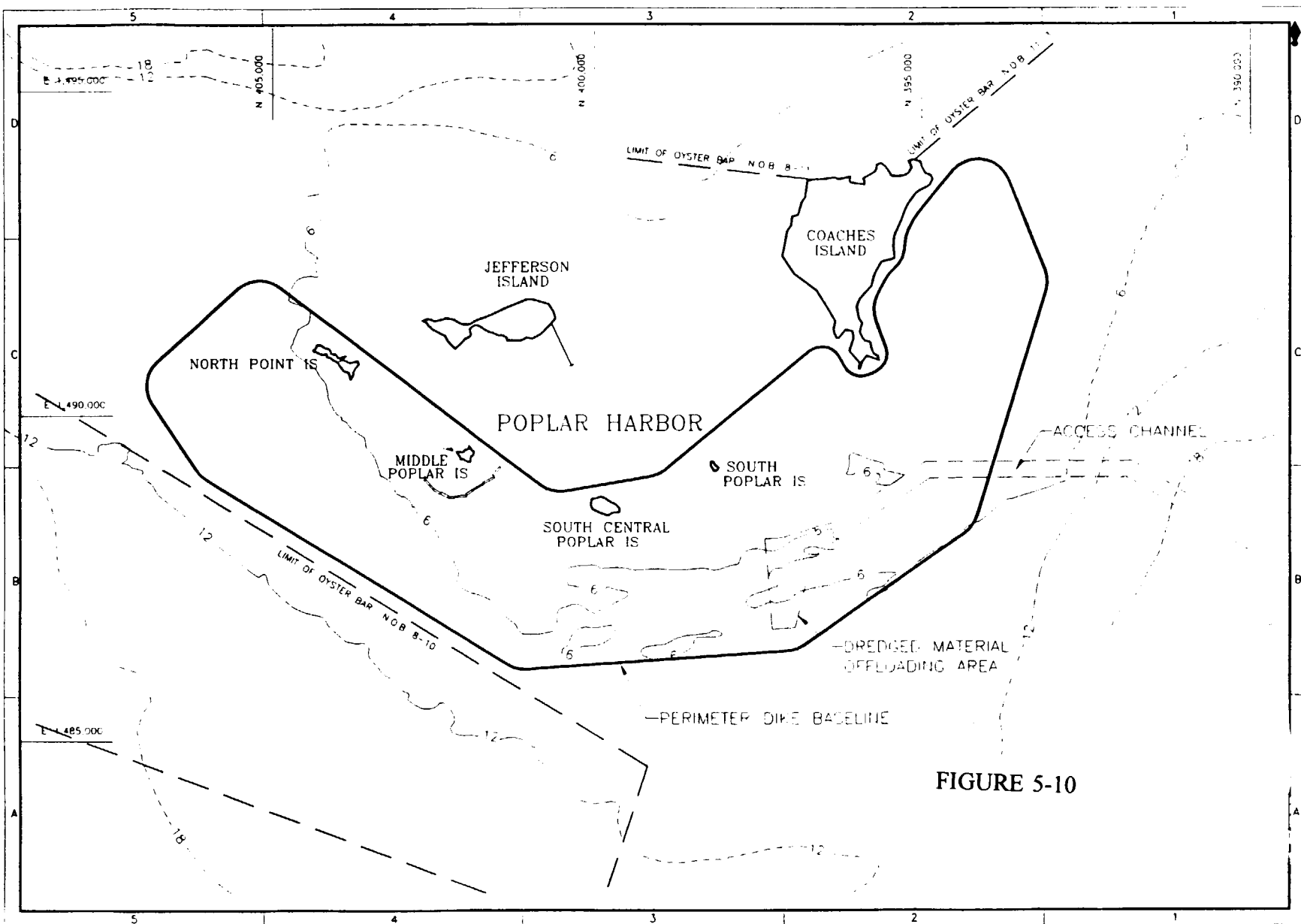


FIGURE 5-10

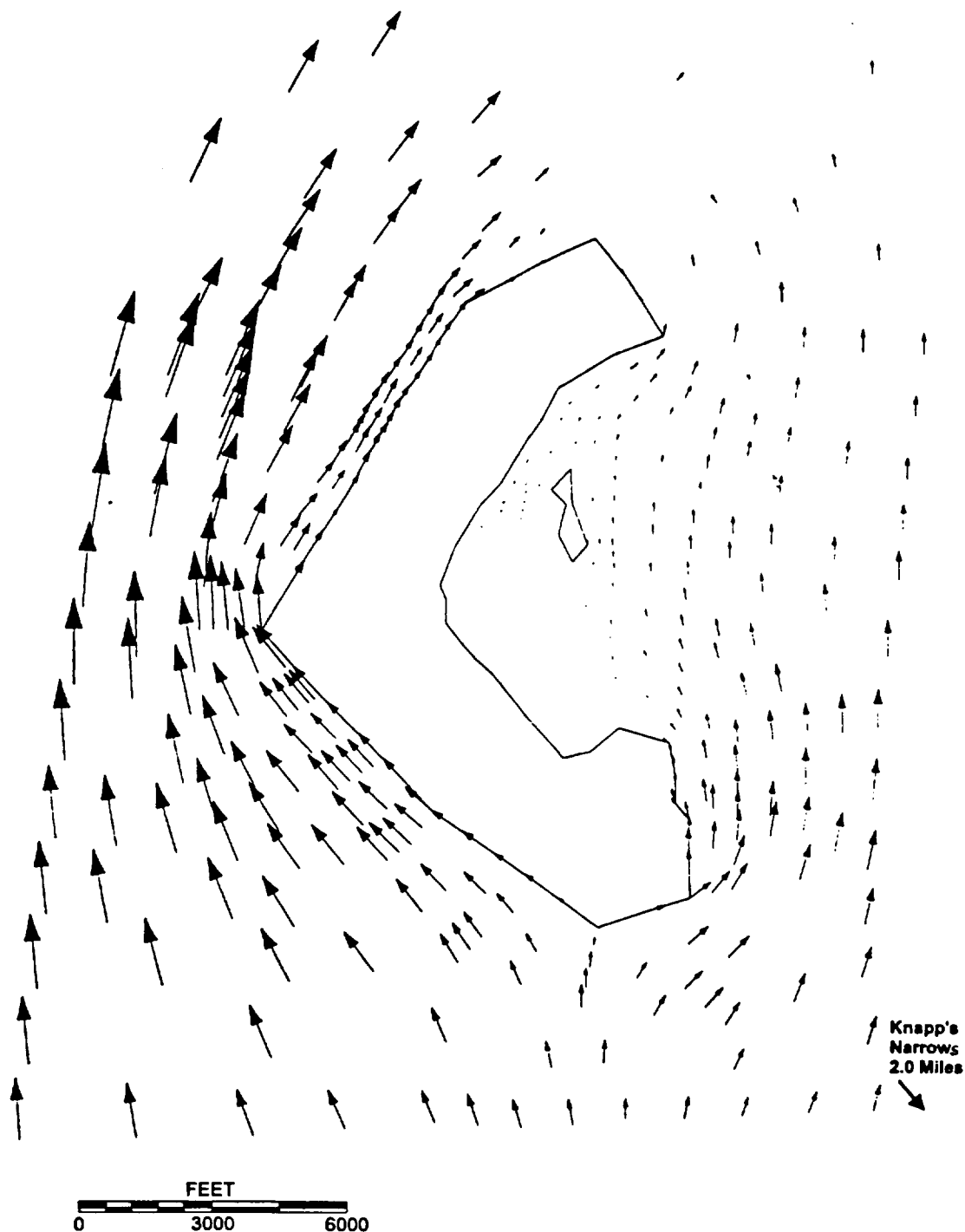
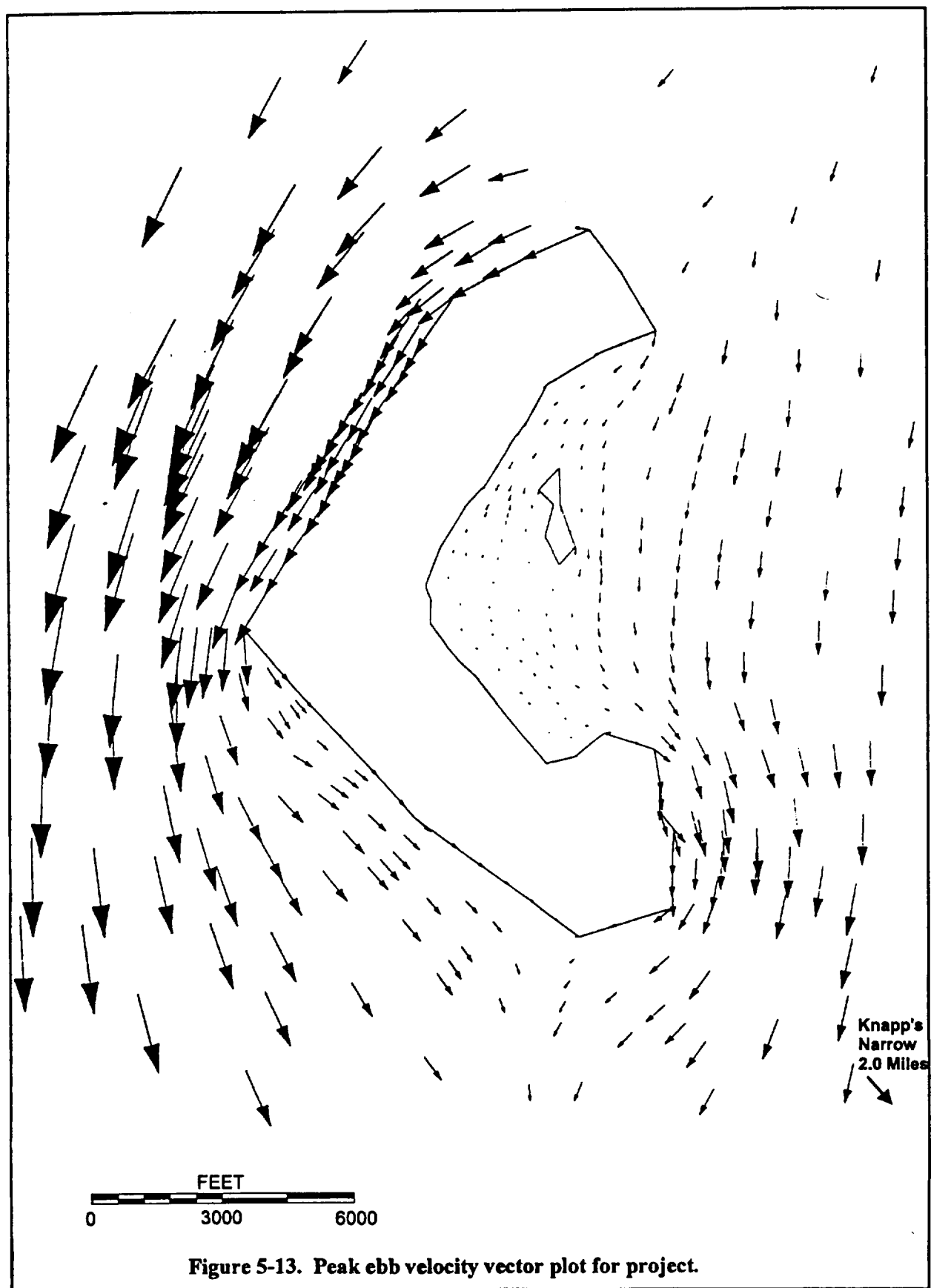
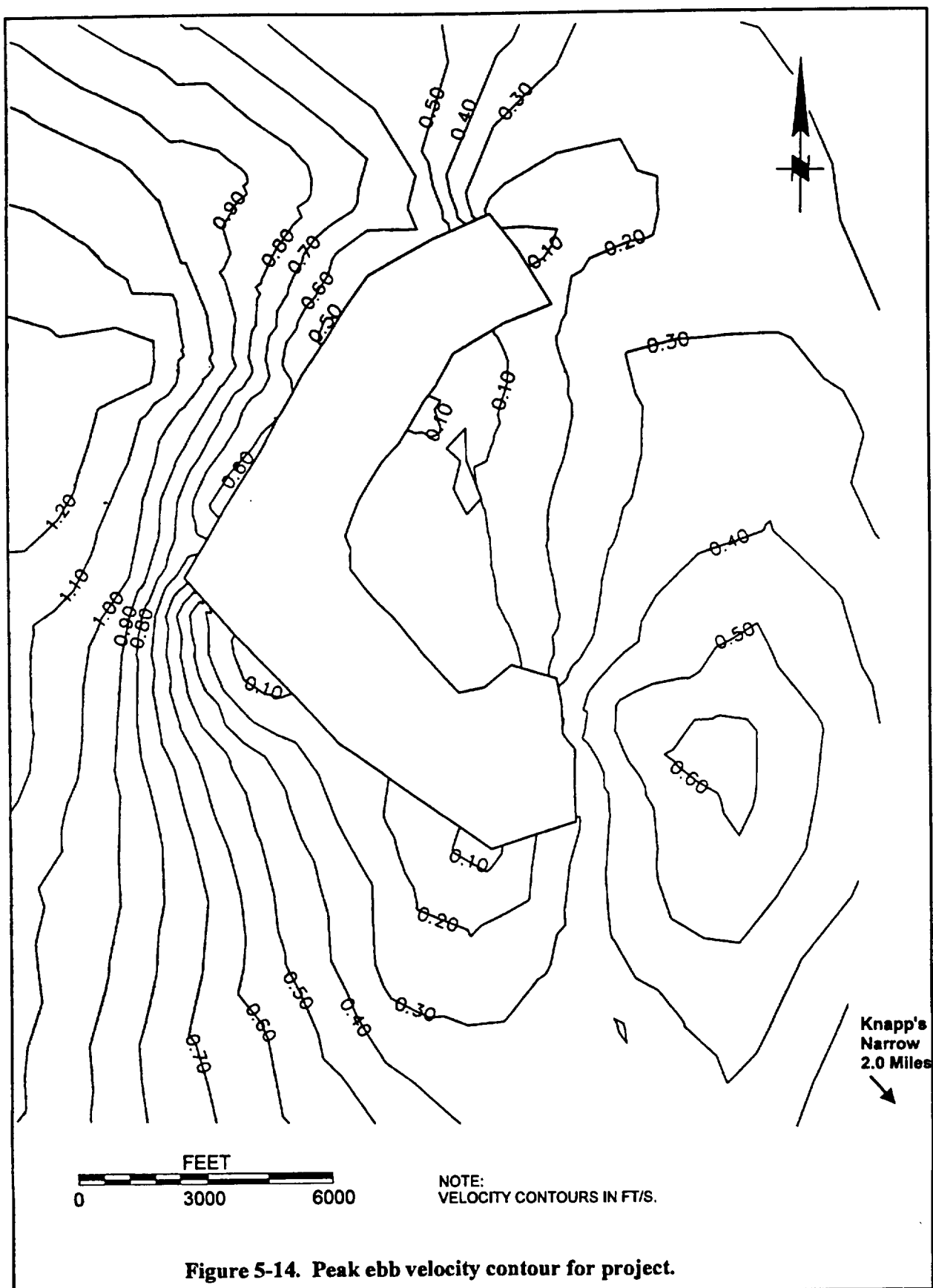


Figure 5-11. Peak flood velocity vectors for project.





be forced to travel around the new island. As a result, existing flow will be reduced within Poplar Harbor and will increase on the exterior edges of the constructed island and Coaches Island.

Under existing conditions, during flood flow, water that passes through Poplar Harbor splits in the vicinity of the point where the proposed dike alignment connects to Coaches Island. After construction, the split flow will train along the southwest dike and the southern and eastern shorelines of Coaches Island. The increase in flow velocity relative to existing conditions will be relatively small, on the order of 0.1 foot per second.

Water flow during ebb will split at the northern end of the proposed alignment and train along the northwest dike and the eastern portion of Coaches Island. Ebb flows fronting the northwest dike will increase about 0.1 foot per second relative to existing conditions. Flow velocities on the eastern shoreline of Coaches Island will increase very slightly, ranging between 0.0 and 0.1 foot per second, relative to existing conditions.

The original mesh used in modeling these flows was refined and expanded to include the Knapps Narrows channel, approximately 2.5 nautical miles southeast of Poplar Island, to evaluate the possible impact on far field areas. Knapps Narrows was chosen as a comparison site because of its proximity to the project and because of the potential impacts to the watermen and recreational boaters who use the channel. Changes in velocity caused by the project will be minimal (G&B and M&N 1995a). According to the specific predictive models used, velocities will slightly increase at Knapps Narrows, and will likely reduce channel shoaling. These changes in velocity are considered insignificant in terms of impacts to navigation because the associated changes in the modeled water depths in Knapps Narrows will be negligible compared to daily tidal fluctuations. The differences in hydrodynamic conditions for the proposed project and those associated with the 1847 condition have been examined. The modeled flow contour patterns that will result from the dike of the proposed restoration project and the flow patterns modeled using the 1847 footprint are similar, assuming that bottom bathymetry over the model mesh are the same for both time periods. This is a reasonable assumption, since only minor changes have taken place in the near field areas around the islands.

5.4.3.b Residence Times. Residence time distributions (average length of time that water particles reside in a basin) for the proposed project and the circa 1847 footprint are given in Figures 5-15 and 5-16. In general, average residence time for existing conditions in the Chesapeake Bay at the latitude of the island are on the order of 5 to 7 days (G&B and M&N 1995a). Residence time distributions over the entire project area (with few exceptions) are not affected by island restoration. However, the residence time in Poplar Harbor will increase slightly, on the order of approximately 0.1 to 0.2 day, relative to the existing conditions. This represents a range of 1 to 4 percent increase, which is not expected to result in any significant impact to water quality. There is significant overall variability in residence times depending upon meteorological conditions, tidal cycle variations, and seasonal influences. Comparisons between the conditions with the restored island and the circa 1847 footprint indicate minimal differences between average residence times, which is consistent with the minimal difference between flow patterns (G&B and M&N 1995a).

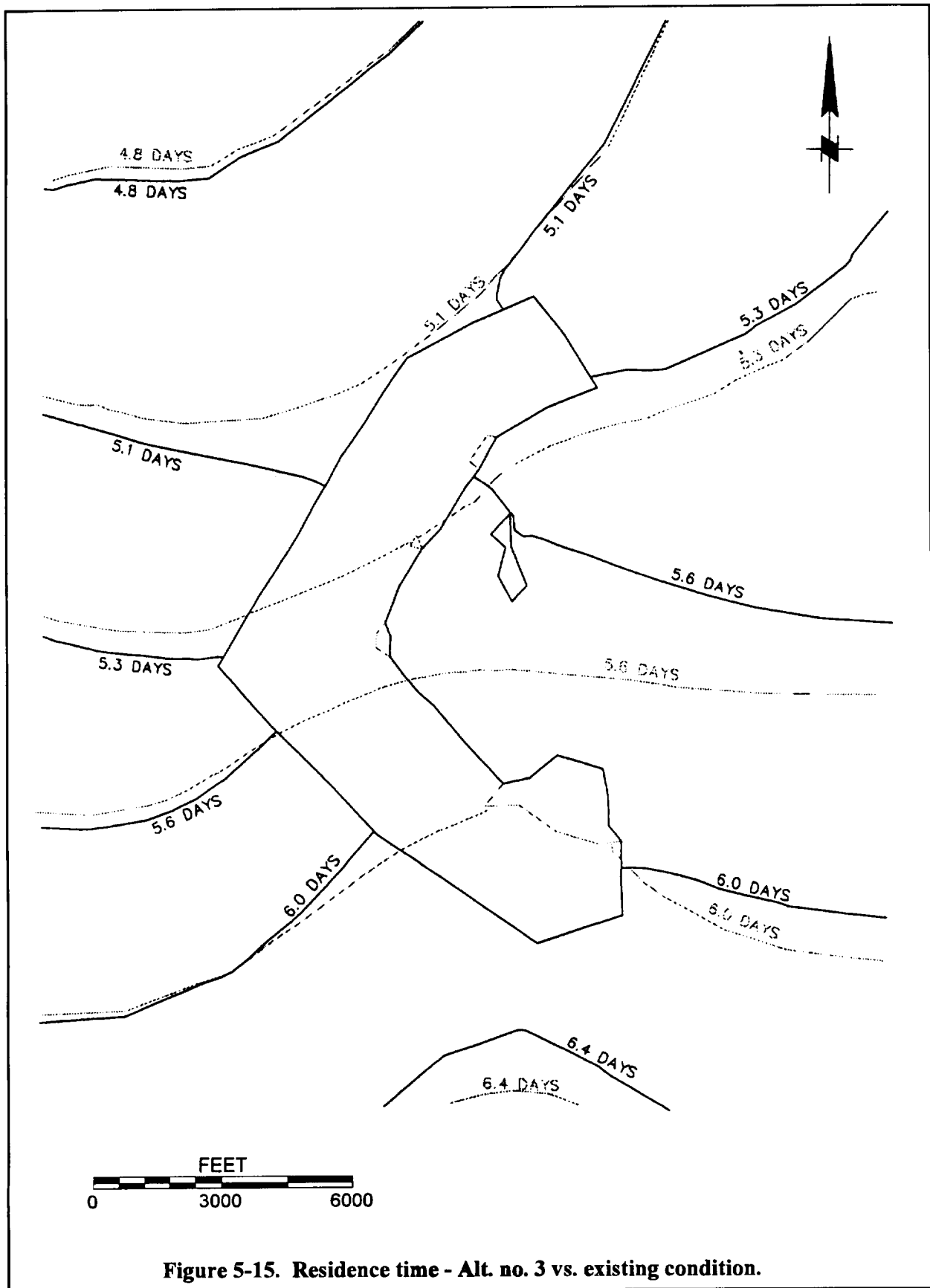


Figure 5-15. Residence time - Alt. no. 3 vs. existing condition.

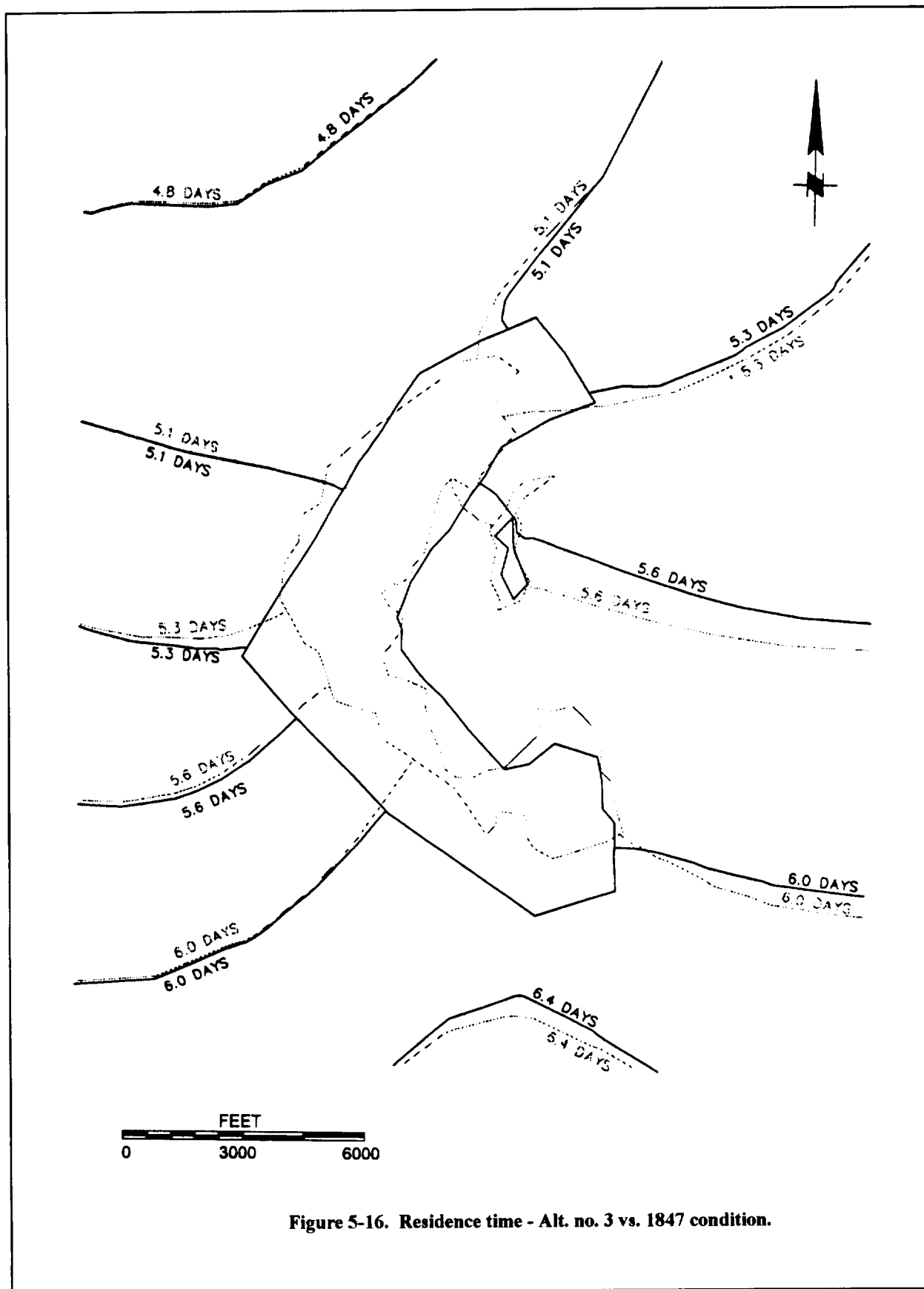


Figure 5-16. Residence time - Alt. no. 3 vs. 1847 condition.

5.4.3.c Sedimentation. Sediment transport with the proposed project was evaluated using models for three wind speeds (10, 15, and 20 mph) from both northwesterly and southerly directions over a sand bottom. When the modeled wind speed was less than 10 mph for both south and northwest directions, neither erosion nor deposition was found to occur at the Poplar Island area. However, for wind speeds of 15 and 20 mph, erosion will likely occur around the western portions of the dikes with a northwesterly wind, and along the eastern side of Coaches Island with a southerly wind. In comparison with the existing conditions, the erosion along the eastern shore of Coaches Island may be very slightly increased because of the flow trained in that direction by the perimeter dike.

As a result of model limitations, constant wind speeds have been used for all simulations. In reality, however, both magnitude and direction of wind change with time. Therefore, a weighted statistical approach, in combination with Monte Carlo simulation, was employed to represent the random nature of wind and to assess possible ranges of erosion around the western dikes and Coaches Island. A Monte Carlo simulation is a randomization test that is used to solve complex mathematical and statistical problems by sampling randomly from a simulated population on a computer.

Based on the probability of wind occurrence computed from measured wind data, Weibull distributions were assumed for both the southerly and northwesterly winds. As shown in the Hydrodynamic and Coastal Engineering reports prepared for this study (G&B and M&N 1995a), mean erosion rates around the eastern side of Coaches Island and western dikes will be 0.023 foot per month and 0.013 foot per month, respectively. These erosional rates are generalized and hypothetical. Erosional rates are expected to slow over time as banks stabilize. Current erosional rates (1846 to 1994) along the proposed alignment average 0.62 foot per month for all points with a range of 1.38 feet per month along the northwest side to 0.023 foot per month in parts of the harbor. Within Poplar Harbor, some areas (close to North Point Island) are actually accreting material, although slowly (0.01 foot per month). Erosional rates for the western dikes expected after construction are, therefore, less than the current average even though the eastern shore of Coaches Island may experience a slightly higher rate than normal. The armoring on the western dikes is expected to protect the structure from significant erosional damage, although some migration of fines will occur over time. The erosion predicted for the east side of Coaches Island is more significant because that area of the island is unprotected. Without protection, the marshes along the eastern shore of Coaches Island are expected to continue to erode. The western shore of Coaches Island will be protected by the project.

5.4.4 Water Quality

5.4.4.a Short-Term Impacts From Site Construction. Short-term water quality impacts will occur from dredging of the access channel and borrow area and from construction of the initial dike. Quarry stone for armoring the initial dike and specific-sized gravel for the dike core will be brought in for dike construction; other construction materials will consist of local sediment, which is currently available from on-site or near-site sources.

The primary short-term water quality impact is expected to be an increase in turbidity in the dredging and construction areas. It is estimated that up to 25 percent of the material dredged from the bottom area could be lost as suspended sediment during placement at the dike (MES 1994, USACE 1995). This loss will be highly variable depending upon the specific locations being dredged, but the losses are expected to be much lower than this maximum. Generally, less than 5 percent loss is expected to occur based on percent fines found during grain-size analyses (Section 3.1.3). It is expected that most of the suspended sediment will drop out of suspension within a 4-hour period. Within this 4-hour period, turbidity produced by dredging the borrow area and placement of fill at the dike may move typically as much as 5,000 feet to the north and south of the work station and less than 1,000 feet to the east and west of each station under prevailing winds and currents. On a daily basis, as winds and currents change, the orientation and size of the turbidity plumes will vary. These plume dimensions are based upon the allowable mixing zone established for preconstruction design testing of the dike segment.

Preliminary studies of the turbidity resulting from dredging in the project area were made during construction of a test dike at the site. This test dike, encompassing several construction techniques, was constructed on the southwest edge of the proposed alignment (Figure 5-17) during August and September 1995. The 2.2-acre test dike included sections of protected (stone armored) and unprotected sand placed via suction dredge, and a section constructed of geotextile materials backfilled with sand. The mixing zone allowed for this construction effort was defined by USACE and MDE. The actual mixing zone as measured during dike construction was significantly smaller. Background turbidity was measured from two locations outside the influence of the plume during plume monitoring and was used as a basis for comparison to plume turbidities. Turbidities at the boundary of the allowable mixing zone were well within the regulatory limits and most of the placement material was found to drop out of solution immediately. Summary data for the monitoring is presented in Table 5.3.

A rough approximation of the locations that could possibly be exposed to the sedimentation caused by project construction can be illustrated by moving the ellipse (representing the allowable mixing zone) around the perimeter of the proposed dike centerline as shown in Figure 5-17. This (calculated) zone could begin overlapping the oyster bar to the west during outer perimeter dike construction from a point approximately 400 feet northwest of the test dike section to approximately the middle of the dike section across the northeast end of the proposed constructed island, a total distance of approximately 10,000 feet. The maximum overlap is indicated during construction of the northwest dike, when approximately half the mixing zone ellipse is expected to lie over the oyster bar. The "water quality mixing zone" could also overlap the oyster bar to the east during outer perimeter dike construction from Coaches Island to a point just west of the southernmost corner of the dike. Maximum overlap is indicated during construction close to Coaches Island when approximately half the mixing zone ellipse is within the oyster bar area. A smaller overlap is also indicated during construction of the first few hundred feet of dike to the northwest of Coaches Island.

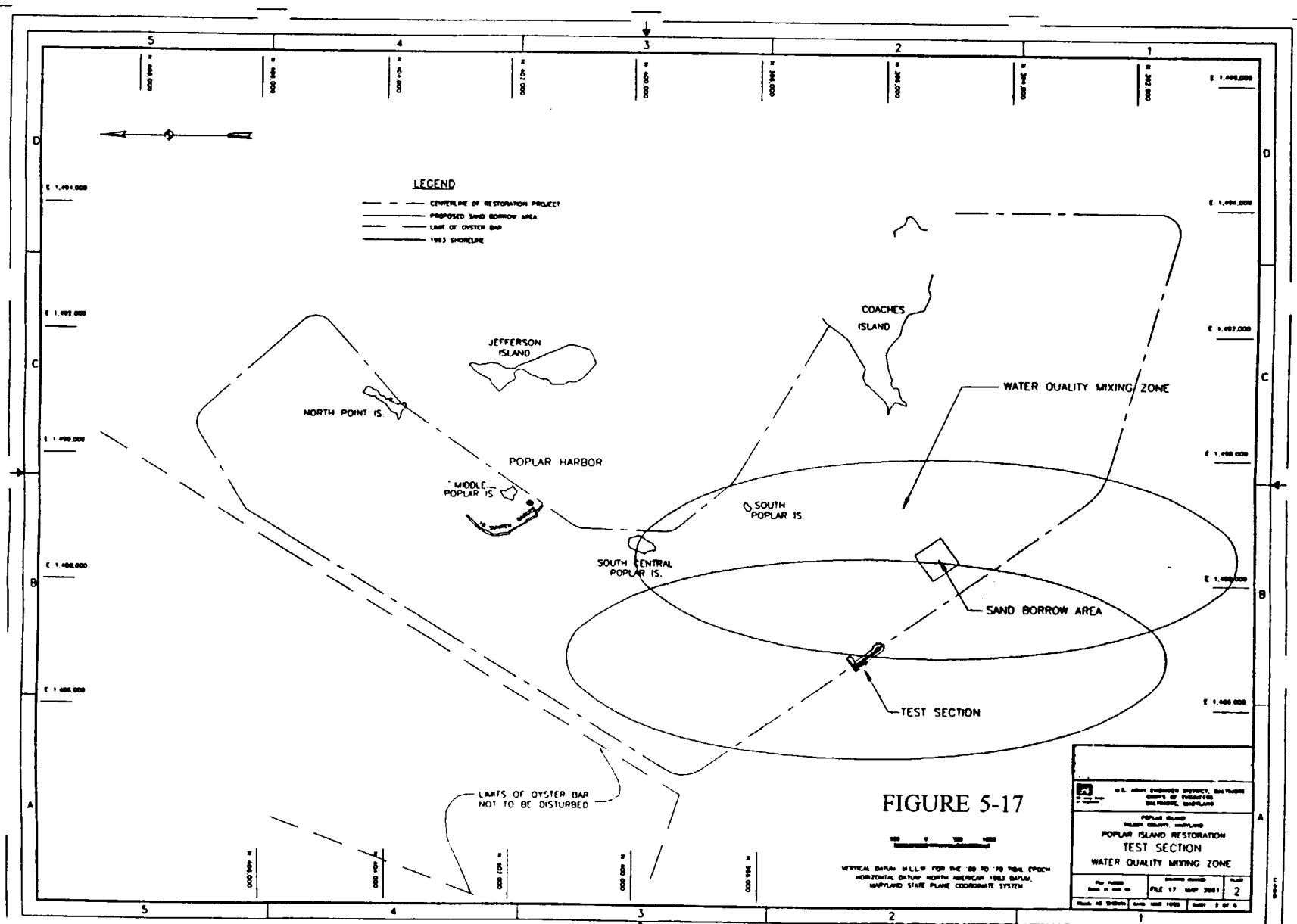


Table 5-3 - Range of values for water clarity (secchi), turbidity (NTU), and total suspended solids (TSS) at Poplar Island Test Dike, 13 August - 4 October 1995.

Station	Secchi Depth (cm)	NTU	TSS (mg/L)
BG-1	135 - 384	1.3 - 4.3	37 - 94
BG-2	104 - 187	2.2 - 10.5	33 - 83
TD-1	80 - 208	2.0 - 11.9	39 - 92
TD-2	93 - 244	1.9 - 12.6	<5 - 93
TD-3	97 - 264	1.6 - 9.7	40 - 100
TD-4	106 - 294	2.0 - 12.0	43 - 98
TD-5	113 - 297	1.4 - 10.2	42 - 107
TD-6	109 - 263	1.8 - 10.4	38 - 95
TD-7	108 - 326	1.5 - 9.6	39 - 94
TD-8	996 - 355	1.5 - 12.9	33 - 115
TD-9	119 - 324	1.4 - 12.4	34 - 121
TD-10	114 - 385	1.4 - 13.1	37 - 108

The turbidity that actually occurs within the water quality mixing zone will be highly variable due to tides, currents, wind, and borrow material. The actual plume would rarely reach the outer edge of the regulated ellipse at any time and even then, would be within regulatory limits. It is expected that the plume would be long and thin in the direction of the maximum tidal current (approximately 5,000 by 500 feet), and, as the tide turned, would become shorter and reach maximum width (approximately 500 by 1,000 feet), then elongate in the opposite direction as the tidal current increased. Therefore, it is expected that only areas very close to the point of construction would experience significantly elevated turbidity within the plume discharge point and would remain elevated for an hour or two during each tidal cycle. These areas in the immediate vicinity of the discharge point would experience this periodic elevation in turbidity for a matter of weeks as construction progressed along the dike length. There is an oyster bar approximately 200 feet from the site; however, oyster bar communities are adapted to natural turbidity fluctuations in this shallow water area, and would not be expected to suffer significant long-term adverse effects due to short-term turbidity from dike construction. The maximum distance of identifiable sediment deposition (as measured by sediment profile imaging) was only approximately 450 feet from the placement point (EA 1996a). It is expected, therefore, that only 200-300 feet within NOB 8-10 will be affected by sedimentation. Regulatory restrictions within the Bay may preclude dredging operations during the periods when the most sensitive lifestages are abundant or during specific periods when

metabolic rates are lower (Table 5-3). Monitoring of dredged material placement in the area of the test dike has indicated that plume densities diminish quickly. Within 1,000 feet of the outflow pipe, NTU values were within the range of background levels (EA 1996a). While some minor turbidity has been noted in the area surrounding the cutter head of the dredge, this is unlikely to have significant impact upon local resources.

Due to the low organic content of the local sediments, the grain size of most on-site sediments, and the excavation method, release of measurable amounts of ammonia is expected to be minimal. There may be some release of ammonia if anoxic sediments are used in dike construction. If ammonia releases do occur, the elevated concentrations would be expected to generally follow the spatial distribution discussed above for suspended sediments. The ammonia would tend to be diluted and ionized relatively rapidly, and, therefore, would not be expected to result in significant long-term adverse effects, such as biological toxicity or eutrophication (nutrient enrichment). The most toxic form, un-ionized ammonia, is not expected to occur in biologically significant concentrations.

No other water quality impacts are expected from the material dredging and placement associated with construction of the site. Impacts from toxic substances are not expected, because the sediments to be moved are local in origin, primarily original substrate and remnant erosional materials from Poplar Island, and there are no known local sources of toxic substances. Impacts from nutrients are also not expected, because the sandy sediments would not be expected, to have significant concentrations of nutrient-rich material. Biological and chemical oxygen demand is also not expected to be significant. Dissolved oxygen reductions may occur locally, but vertical mixing is complete throughout much of the area, and stratification is not expected to occur.

5.4.4.b Long-Term Impacts. It is expected that some long-term water quality impacts will result from the operation of the dredged-material placement site and from the effects of the restored island and wetlands.

During operation of the placement facility, water will be displaced from the interior of the diked area as new dredged material is added. This water will consist initially of Bay water and rainwater trapped within the dike as it is constructed. As operations continue, this Bay water will be mixed with water transported with the dredged material, additional Bay water used to pump dredged material into the site, and with rainfall. Water will be discharged to the Bay through several adjustable weirs along the eastern, northern and southern perimeter dikes. Internal diversions will be designed and constructed to ensure adequate settling of suspended sediment prior to discharge into Bay waters. The large volume of water returned to the harbor and Bay will cause periodic hydrodynamic changes in the harbor. These changes will be more noticed because the project will effectively block strong tidal flows between the islands. No long term impacts are expected.

Rainwater inputs to the upland cells will, by necessity, have to discharge through developing wetlands as construction progresses. Salinity of these discharges is expected to fluctuate widely due to the salt content of the dredged materials and the freshwater inputs from

rainwater. To avoid potential impacts to the developing wetlands, discharge channels will be constructed to temporarily divert water around the wetlands.

The project requires that only clean sediment from the outer approach channels to Baltimore Harbor be used for fill. Significant water quality impacts from sediment placement operations are not expected because of the uncontaminated nature of the source material. Within the diked area, the primary water quality impact is estimated to be increased turbidity. However, the diked area will serve as a settling pond and treatment basin. The shallow pond and long travel path between placement area and discharge weir will promote settling of all but the finest material. The weirs will be controlled during placement operations in order to minimize the release of suspended solids. Turbidity in the discharge is expected to be near ambient background levels.

Ammonia can affect water quality because of its oxygen demand, its availability as an algae nutrient, and its toxicity at high concentrations. Due to the high ratio of surface area to water depth within the diked area, it is expected that natural aeration, coupled with the maintenance of proper pH and the expected presence of nitrifying bacteria will be adequate to convert much of the ammonia to nitrate, thereby substantially reducing the oxygen demand of the discharge to the Bay. Whether as ammonia or nitrate, however, nutrient concentrations in the discharge may be higher than ambient concentrations. During the fall and winter months, the middle Chesapeake Bay can be nitrogen-limited, so that the addition of nitrogen as ammonia or nitrate during those seasons may cause local increases in algae biomass in the embayment east of Poplar Island. There will be no placement of dredged material in the summer which will be used for crust management and de-watering. Water discharged from the site will be aerated and oxidized and must meet water quality standards. Water quality will be monitored closely and the project managed to minimize deleterious water quality impacts.

As each wetland cell of the placement area is completed, its exterior dikes will be breached to allow normal tidal flushing of the new wetland habitat. Long-term impacts on water quality in the project area are expected to be beneficial. The wetlands will generally serve to convert soluble nutrients in tidal water into organic detritus that will be exported back to the embayment east of Poplar Island. This detrital material will provide substrate for bacterial growth and benthic community enhancements in the shallow waters of Poplar Harbor.

5.4.5 Sediment Quality

Since the project is specifically proposed to contain only clean sediment from project channels in the central Bay leading to Baltimore Harbor², no significant sediment quality impacts are expected. Both the proposed construction site and the project channels that would be dredged to provide material for the wetland and upland habitats are removed from known sources of

² Specific channel reaches include the Craighill Entrance Channel, the Craighill Channel, the Craighill Angle, the Craighill Upper Range, the Cutoff Angle, the Brewerton Channel Eastern Extension, the Tolchester Channel, and the Swan Point Channel.

anthropogenic contamination. Subsequently, we do not expect contaminant related impacts to result from project construction.

Confirmatory testing of project sediments is currently underway and will be repeated at intervals not to exceed three years during the life of the project. Testing and evaluation will conform to guidance provided in *Evaluation of Dredged Material Proposed for Discharge in Waters of the U. S. - Testing Manual* [Inland Testing Manual] (EPA/USACE 1994). Contaminant levels in channel sediments will be compared to reference sediments collected near the Poplar Island site. For the most part, analyses will focus on the Priority Pollutant List less the volatile compounds which are seldom present in dredged material and which would necessitate specialized sampling procedures. Results from the analyses currently underway and from future confirmatory testing episodes will be available for inspection at the Baltimore District office and will be appended to Poplar Island Monitoring Reports.

Dredged materials that are placed in upland cells are exposed to the atmosphere and weathering. Exposure of sulfidic marine sediments sets off a chemical reaction that tends to lower sediment/soil pH. This reaction and the exposure to rainfall (which also has a low pH) causes some metals that are bound to the sediment to dissolve into the water. Dissolved metals can be toxic to aquatic organisms, if present at sufficient concentrations, and could constitute a negative impact to the local biota, particularly in Poplar Harbor in the short term. This potential impact is lessened by the placement of clean material. In addition, upland soils will be conditioned periodically to maintain a neutral pH, which will keep metals bound to the sediments/soils. Water quality at the weir will also be continuously monitored so incidences of low pH and high metals can be identified to minimize impacts to local water quality. The reconstructed salt marsh will act as a filter for potential release of metals; therefore, no water quality perturbations are expected in the long term.

5.4.6 Aquatic Resources

Impacts to the aquatic resources of the Poplar Island area can be categorized as short-term construction impacts (less than or approximately 2 years) and as long-term impacts (2 - 30 years) of material placement and marsh creation. Construction of the initial dike will include dredging an 8000 ft long access channel from deep water south of the proposed alignment to a staging area near Poplar Harbor (Figure 5-10). The channel will be dredged to a width of 300 to 400 feet and a depth of 25 feet, and approximately 2 mcu of material will be removed. Approximately one half (4000 ft) of this channel will be located within the containment area and one half (4000ft) will be located outside of the containment area. In addition, borrow material will be dredged from the project site for placement along the dike alignment. These activities will disturb the bottom in the dredged channel and borrow areas, as well as locally elevate turbidity and possibly nutrients during dike material placement. Dike construction will bury existing areas of the bottom along the proposed alignment and may affect adjacent areas of the bottom through drift and settling of finer particulates.

After initial dike construction, dredged material from other areas of the Bay will periodically be placed within the diked area. Short-term localized elevations in turbidity will likely be associated with placement of material due to the operation of tug and barge traffic in the relatively shallow waters surrounding the proposed dike alignment, and in the access channel. The most significant impacts to the aquatic resources of the area will be burial of 1,110 acres of Bay bottom in a relatively shallow area within the dike, with subsequent construction of tidal marsh and uplands over the area. Other potential impacts include sediment, nutrient, and possibly ammonia releases from the contained area. Long-term impacts are expected to be positive. The wetlands will mature and provide high quality detritus to adjacent waters of Poplar Harbor. The new habitats, both wetland and upland, and significant transitional edge areas will provide a wide range of diversity in bird and fish populations in the tidal channels and adjacent waters.

5.4.6.a Phytoplankton and Zooplankton. In the short term, the turbidity associated with dredging and dredged material placement is likely to suppress light penetration into the water column and could locally depress the phytoplankton community. Significant increases in nutrient concentrations due to dredging activities are not expected, except in the immediate area of the discharge. These localized increases would tend to elevate phytoplankton concentrations, but this is not expected to be significant because of the small amounts of nutrients released. Since the project is in an exposed area, tidal currents and wave action are expected to lessen localized effects on the phytoplankton through exchange with nearby waters. Phytoplankton and zooplankton will be entrained in sediment slurry at the borrow site during construction; the impact will be localized and not significant in the long term. The short-term effects on the phytoplankton are, therefore, expected to be negligible. As a result, zooplankton communities that are dependent on phytoplankton densities are not expected to be limited by food availability. Effects on photosensitive zooplankton species due to localized light penetration are expected to be short lived due to current exchanges and rapid settling of most of the materials. Placement activities in the project area will continue over the life of the project, resulting in a relatively consistent area of higher turbidity within a specific distance of the discharge point. The affected area, however, will be small relative to the overall area of the archipelago. It is also important to note that the Poplar Island area already experiences significant turbidity events daily due to island erosion. Based on the chlorophyll concentrations and zooplankton densities noted during the summer survey (EA 1994d) versus those observed at state monitoring stations (Section 3.1.3.), there are no indications that events have had even a negligible effect on the plankton.

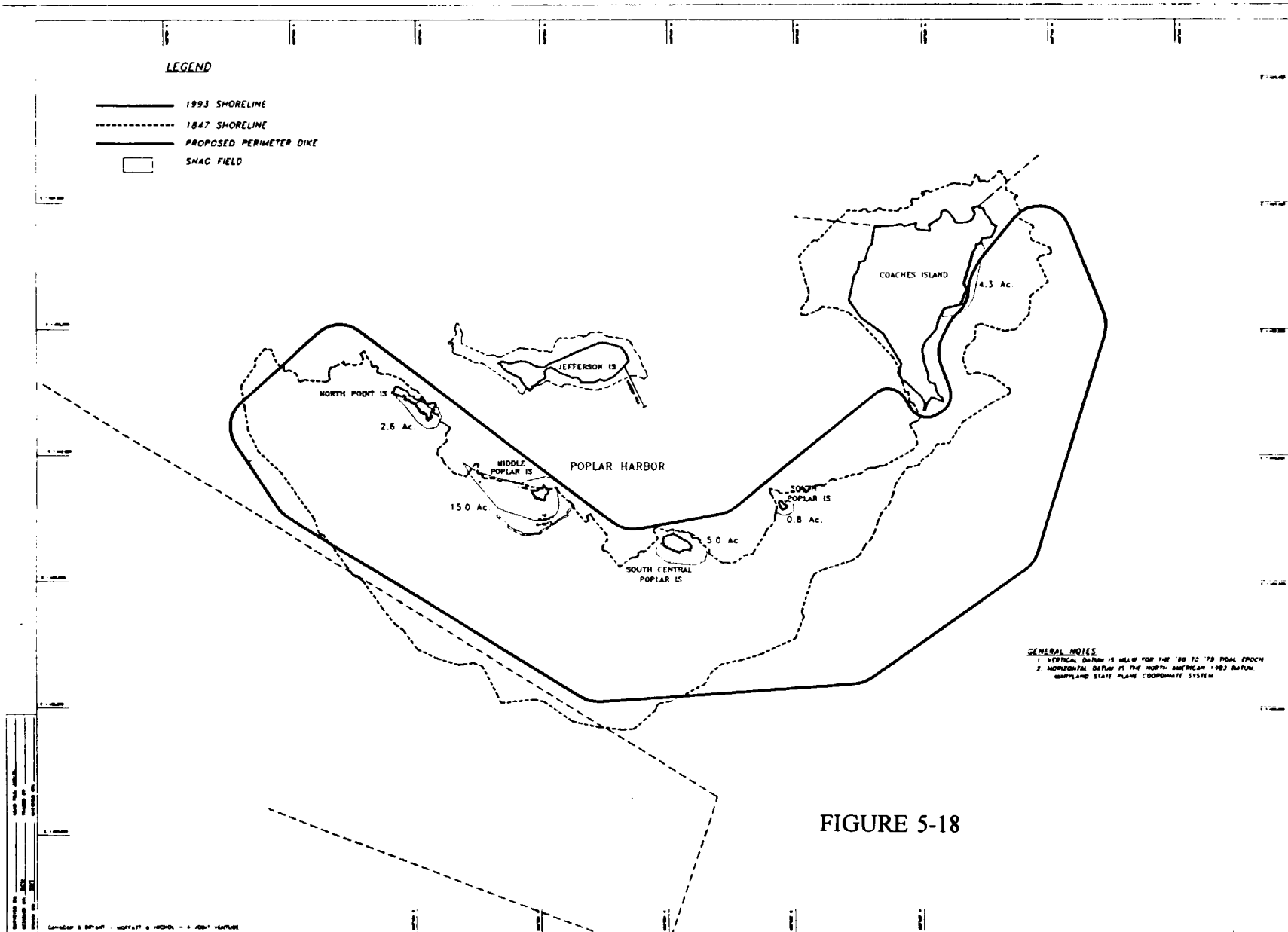
Dredged material placement within the proposed dike is not expected to measurably affect plankton communities outside of the dike. Reconstruction of the island communities, especially the salt marsh, is expected to have a stabilizing influence on the plankton communities in the immediate vicinity of the archipelago. It is expected that the development of salt marshes on the east side of the restored island will particularly benefit Poplar Harbor. Salt marshes are known to filter nutrients from the water, moderating the availability of free nutrients that can cause rapid phytoplankton blooms followed by oxygen-depleting decay. Moderation of phytoplankton blooms will not only stabilize dissolved oxygen within the

system, but will also improve light attenuation during key periods in the development of photosensitive organisms such as SAV.

5.4.6.b Fisheries Resources. Construction activities are expected to affect the fish community in several distinct ways. Dredging of the access channel and borrow area and subsequent placement along the dike alignment will disturb less than 100 acres of bottom. Pelagic fishes (e.g., menhaden, striped bass) and more mobile members of the demersal fish community (e.g., flounders) are expected to easily move out of or generally avoid the area during dredging. The fishes most affected would be smaller, mostly resident species of limited mobility (e.g., gobies, blennies) and the young of fish utilizing the area as a nursery. Those within influence of the suction head will be entrained with the material being moved, and some of those along the alignment may be trapped and destroyed as the material is placed. This is expected to be a very small portion of the local fish community, and the action is not predicted to have lasting impacts on any species.

The short-term elevated suspended solids levels associated with dredging within the project area are expected to have a negligible effect on larger members of the fish community that will likely avoid the areas of highest turbidity. Early life stages are expected to be most affected: eggs and larvae/juveniles of many fish species are sensitive to high turbidity. Many fish eggs are adhesive and readily accumulate particulates, making them less buoyant (in the case of pelagic eggs) or smothering them (in the case of demersal eggs). Some larval fish are similarly affected by high concentrations of particulates. Suspended solids are also known to influence the feeding abilities of some larvae/juveniles, particularly those most dependent on vision to detect prey (e.g., young striped bass). The extent of impacts to fishes in the area during early life stages is speculative because so few fish eggs/larvae were collected during existing conditions surveys (Section 3.1.6.c). Because the reasons for poor ichthyoplankton abundances cannot be determined from the existing conditions surveys (collection methods vs. organism distributions), project impacts cannot be determined. The fish species most at risk to perturbations of early life stages are those with demersal eggs (e.g., silversides, gobies, blennies). These species are, however, all very common regionally, and any impacts to the populations would be short term.

When construction is completed, any fish walled within the proposed dike will likely be lost. Existing conditions surveys confirmed that all species currently using the area are common in the Chesapeake Bay and typical of the mid-Bay region. The loss of fish habitat within the diked area is considered the more significant impact. Existing conditions surveys indicated that much of the open water in the vicinity of the archipelago was bereft of cover items, particularly SAV and viable oyster bars (although some occur nearby). The most significant cover found within the study area was provided by the submerged trees and snags, remains of the forests that formerly covered the remnant islands (Figure 5-18). The snags occupy an estimated 27.2 acres, or 2.5 percent of the containment area. These have been noted as important habitat for striped bass (among other species) and would be buried within the containment area. The loss of the snag fields is of some importance, because a structure of



this type provides "reef" habitat within the relatively open homogenous sand flats of the mid-Bay region. The snags are, however, short-term structures that will disintegrate with time and are not unique to Poplar Island, but which exist throughout the Bay. Moreover, the protected cove created by Poplar Island may create conditions conducive to the recruitment and growth of SAV, a habitat type that is currently areally restricted in Poplar Harbor. The stone armor that will protect the dike in many areas is also expected to provide cover for some species, although utilization of these structures is often limited. In addition, the stone armor will provide a food source upon colonization of the rocks by epibenthic species. Construction of groins or rock piles along the dike wall to provide bottom diversity/cover is expected to increase the value of the rock walls as refugia (reefs).

An important habitat feature of an archipelago is the shoreline. Shallow near-shore areas have been noted as being among the most productive habitat of some estuaries, second only to tidal marshes (Ayvanzian *et al.* 1992). The presence of this habitat (within the archipelago) is not unique to the region, but it is unique in its occurrence so far from the mainland (surrounded by areas of much deeper water). Approximately 1,000 acres of shoreline and near-shore habitat will be buried within the containment area, including the four Poplar Island remnants and their associated shorelines. This, however, constitutes only a minimal loss of shallow open water areas regionally, less than 1 percent within the mainstem Bay from the Bay Bridge to the mouth of the Potomac River. Although a large shoreline will eventually be constructed, there will be a period of time during which the shore of the proposed island will be predominantly rip-rap, which does not have the same habitat value as a natural sand beach. Some of this loss will eventually be ameliorated by the construction of the salt marsh on the eastern shore of the proposed island, but this will be a shift in habitat types with a net loss of shallow sandy-bottomed open water and sand beach habitat currently within the proposed dike alignment. However, over time, it is also expected that some additional shallow sand beach will develop through accretion along Poplar Harbor portions of the dike and along any finger dikes constructed as reef areas. The tidal gut that will remain open between the proposed island and Coaches Island is also expected to provide some additional shoreline habitat.

This shift in the predominant aquatic habitat is expected to manifest fundamental changes within the fish community utilizing the area during the transition period following dike completion, particularly within and directly adjacent to the proposed dike alignment. The most significant change is that the only open water within the proposed alignment will be marsh creeks and ponds. This will preclude use of the area by adults of some of the larger species that utilize the deeper areas around the archipelago, which were found during existing conditions investigations. The usage is expected to shift to earlier lifestages and to smaller species that commonly utilize marsh creeks and ponds. Species composition in the waters surrounding the proposed island is not expected to change significantly in the long term. Monitoring studies of similar beneficial usage projects in northern and southern estuaries have revealed nearly identical species compositions before and after marsh creation (Landin *et al.* 1989, Newling and Landin 1985).

5.4.6.c Commercially Important Species. Existing conditions studies in the project area found that five commercially important finfish species and three species constituting the "herring"

group utilize the area at various times of the year. Of these, the most important in terms of poundage landed and dollar value were striped bass and Atlantic menhaden; several lifestages of each of these species were collected. As stated previously, the composition of the adult finfish community in the waters surrounding the proposed alignment is not expected to be impacted significantly in the long term (Section 3.1.6.b). However, construction impacts such as bottom disturbance or turbidity may deter short-term usage by the adults and young of some commercially important species (e.g., flounder). In addition, burial of available cover items such as snags would remove preferred habitat for species such as striped bass. Pelagic species (e.g., herrings) may avoid the area completely during construction activities, but the young (particularly the planktonic stages) may not be able to. It is not anticipated that any long-term impacts to commercially important finfish will be significant, and, once the construction phase is completed, finfish are expected to move back into the area quickly.

Two commercially important bivalve species, soft clams and razor clams, occur within the proposed dike alignment. Dredging and construction of the containment facility is expected to permanently eliminate the bivalve community that currently inhabits the bottom within the dike alignment. Moreover, there would be no potential for reestablishing that portion of the former Bay bottom shell fishery because the area would be completely covered with dredged material when the island was constructed. Since both of these clam species occur inside and outside the proposed alignment, populations are expected to reestablish adjacent to the proposed island after construction. The soft clam beds in areas adjacent to the proposed island have been historically productive, and soft clams typically produce thousands of young per spawn. Soft clams, therefore, are expected to repopulate adjacent areas within two or three years, post-construction. The timing of this recovery is, however, speculative and may depend upon the timing of construction activities relative to peak spawning and recruitment for these species and also upon regional population trends for the species. For example, soft clam harvests (one gauge of population density of adults) are currently in a decline (Section 3.1.6.c); fewer numbers of adults may affect the numbers of young produced to repopulate various areas over the next several years. However, the soft clam beds in areas adjacent to the proposed island have historically been very productive and recent surveys indicate active recruitment of young both inside and outside of the proposed alignment indicating a potentially healthy parent stock within the next several years. Additionally, individual clams produce millions of eggs and larvae and the planktonic stages can remain in the water column for long periods, adding to the possibility of recruitment from area outside of the influence of the project.

Suspended sediments from initial dike construction activities may also depress recruitments in the near-field during construction activities. Although not expected to drift more than 500 feet from the site (EA 1996a), particulates settling over bivalves may suffocate the young within the area of influence, postponing recruitment in these affected areas until construction activities are completed. It is anticipated, however, that construction of the salt marsh will increase productivity of the shellfish populations once the marsh is established and functioning by localized moderating of available nutrients which is expected to enhance productivity of bivalve food sources (phytoplankton and zooplankton).

Two charted oyster bars are located adjacent to the proposed dike alignment. NOB 8-10 is located adjacent to the dike on the northwest side of the proposed alignment. NOB 8-11 is located along the eastern side of the archipelago (Figure 3-14). Only NOB 8-10 is currently believed to be productive (Section 3.1.6.c, Figure 3-14). The proposed dike alignment is configured such that no dredging, construction, or filling activities will occur over any oyster harvesting areas. The staging area for material placement will be sufficiently far from NOB 8-10 to prevent impacts from resuspension of material due to barge traffic. No long-term impacts from the project on the adjacent oyster bars are, therefore, expected. Short-term impacts to these bars from the project could result from suspended sediment drift during dike construction, particularly to the planktonic larvae and spat (newly settled young). Dredging restrictions within the Bay in the summer (June through August) are designed to avoid entrainment of and provide protection for these lifestages. These restrictions will be closely adhered to during construction. A second dredging restriction time occurs during periods of low metabolic rates when oysters are more susceptible to smothering by suspended sediments (December to March). These beds and the nearby clam beds are currently exposed periodically to higher than background levels of natural turbidity due to island erosion. Stabilization of the islands is expected to eliminate this source of turbidity and protect the remaining beds from impacts related to suspended sediment in the future.

Table 5-4: Inland Dredging Restrictions for Chesapeake Bay

Period	Agency	Protected Resource	Conditions
February 1-April 15	National Marine Fisheries Service	Anadromous Fish (Migrations)	Unconditional
June 1 - August 31	MD Dept. of Natural Resources-- Shellfish Division	Oysters--Spawning, larval development and early spat (newly settled)	Dredging within 1500 feet of a viable bed
December - March	MD Dept. of Natural Resources-- Shellfish Division	Oysters--Adults during the fattening period	Dredging within 1500 of a viable bed

from: (GBA and M&N, 1995c)

The waters surrounding the archipelago had been identified as a regionally important area for harvesting of blue crabs. This was confirmed during summer existing conditions surveys through observations of substantial commercial crabbing efforts in the area (EA 1995d). Short-term impacts to blue crabs are expected to be similar to those of the finfish resources. During dike construction, there will be a period of lowered usage of the archipelago by blue crabs, and those trapped within the dike at completion will be lost. These losses are expected to be minimal, particularly if dike construction is completed when the crabs are in deeper waters (October through April). The most significant impact to this resource will be the loss of 1,110 acres of prime summer blue crab habitat to burial and island construction. The snag areas and the relatively protected Poplar Harbor are valuable habitat for juvenile and molting

stages. The shallows surrounding the remnant islands provide habitat (cover and food sources) sought by juvenile and adult crabs in the summer. The marsh creeks and protected harbor formed by the restored island construction are expected to provide excellent crab habitat in the future (particularly for young lifestages and peelers/soft crabs), but island construction represents a net loss of currently productive blue crab habitat.

5.4.6.d Benthic Invertebrates. Benthic invertebrates, especially infaunal components, are strongly dependent upon biological, physical, and chemical characteristics of the surrounding substrate. This dependence, combined with low mobility, makes benthic infaunal organisms, such as clams, particularly sensitive to the disruption associated with dredging and dredged material placement (McCauley *et al.* 1977). Because of the engineering design of Poplar Island, measurable impact would be expected to be restricted to the area within the diked perimeter and beneath the dike itself.

Short-term impact to the benthos will result from dike construction, dredging of the access channel, material placement activities, and ship movement in the area. Recovery of benthic resources will occur outside of the reconstructed island after cessation of disruptive activities in a specific area.

Dredging of the access channel and the sand borrow area for dike construction will completely disrupt the indigenous benthos living in the material that will be moved and within the influence of the sediment plume associated with the operation. This is dependent upon sediment type and wind/current conditions in the area. Actual disturbances from this construction were measured to within 5000 feet of the test dike (EA 1996a, in progress).

The effects of dike construction on the benthic community are expected to be restricted to the placement area and to an area adjacent to the dike within 500 feet of the proposed alignment. The benthic resources buried under the base of the dike will be lost, but the impacts outside of the alignment are expected to be of short duration. Many benthic infaunal organisms can survive a moderate silt layer covering by burrowing upward, and the community can also recolonize a disturbed area through recruitment and immigration.

The impact of dredged material placed within the containment area will depend on the extent of particulate dispersion from the site. Disturbance may occur before containment is completed and fine sediment is deposited on surrounding benthic communities. Many infaunal organisms can move rapidly enough to avoid being covered by particulates. This has been documented, for example, in bivalves by Shulenberger (1970). Some components of the benthic community (e.g., filter feeders) are sensitive to high turbidities, particularly over protracted periods when turbidity may influence long-term feeding effectiveness. Duration and distance of particulate drift from the dike will determine the overall effect on the benthic community.

Maintenance of the access channel and construction activity in the area will result in periodic disturbance to the adjacent benthic communities until all placement of dredged material is completed. Vessels operating in shallow waters can cause considerable sediment disruption.

Some taxa are able to cope with persistent sediment instability, but community alteration will continue until construction and fill activities are completed. Once dredging and disturbance has ceased, recovery of the benthic community should occur within 1 to 2 years (Pfitzenmeyer 1970), although some opportunistic species, particularly polychaetes, will recolonize an area within weeks after a disturbance (Sanders *et al.* 1980, Grassle and Grassle 1974).

The most significant long-term effect will be the elimination of most of the existing benthic community in the 1,110-acre area to be covered with dredged material. Existing conditions surveys have indicated that the area to be filled is not a unique habitat and that the area is not inhabited by a unique benthic community when compared to other shallow areas in the Mesohaline portion of the Chesapeake Bay. The similarity of community composition (including soft clam distributions) inside and outside the proposed alignment can be attributed to the relatively homogenous substrate composition (85 percent to 99 percent fine sand) throughout most of the archipelago (Section 3.1.6.d).

Construction of marsh creeks will reestablish some benthic habitat within the proposed alignment; however, re-establishment may require a time period of several years. This new habitat is expected to be markedly different from the existing habitat since it will be shallower and will consist of finer substrate composition. The shallow, better protected environment of Poplar Harbor that will result from island restoration is expected to eventually produce a productive benthic invertebrate community that will attract fish and wildlife to that area. Recolonization may be facilitated quickly due to the presence of "seed" organisms occurring in the sediments of the current wetlands which will be incorporated into the reconstructed marsh. The current benthic community within Poplar Harbor will also provide "seed" organisms for benthic recruitment.

Some nutrient export is expected from the containment area following material placement, dewatering, and marsh construction. This may enhance benthic productivity periodically during project development due to short-term increases in planktonic food sources. Marsh creation, however, is expected to eventually moderate nutrient fluxes in the waters surrounding the proposed island and to have a stabilizing effect on the nutrient cycle.

Horseshoe crab spawning has not been confirmed in the archipelago. If spawning does occur, short-term impacts include elimination of suitable spawning habitat on the four island remnants. The dike alignment will not abut the south shore of Coaches Island, and will not impact this habitat, which is potentially suitable for horseshoe crab spawning. Over the long term, the reconstructed island will create suitable spawning habitat (protected from waves and surf) within Poplar Harbor.

5.4.6.e Submerged Aquatic Vegetation. The waters surrounding the Poplar Island archipelago provide many of the physical habitat characteristics key to SAV growth and success. These characteristics include shallow water protected from wave action, with relatively good water quality and clarity. However, recent SAV surveys of the waters surrounding the Poplar Island archipelago revealed that the presence of SAV species was minimal (EA 1995c,d). Site-specific degradation of habitat quality, particularly wave action and the associated turbidity

from erosion of the remaining land masses, is believed to be the primary cause of the Poplar Island SAV decline in recent years (Section 3.1.6.e).

The area of greatest SAV density identified during the existing conditions surveys was outside the proposed dike alignment adjacent to the point where the easterly perimeter dike will abut Coaches Island (Figure 3-16). No SAV was found inside of the proposed alignment, and only one other potential occurrence (near Jefferson's Island) was found, although root stocks were not located.

No short-term impacts to SAV due to access channel dredging are expected because the channel does not cut through any known areas of root stock occurrence. The proposed channel is far enough from the confirmed bed adjacent to Coaches Island to prevent significant increases in suspended solids during channel dredging from affecting the bed. The perimeter dike, however, will come within approximately 300 feet of the bed. Dredged material placement may cause turbidities near the SAV bed to be elevated during construction of that portion of dike, which may result in some short-term impacts. However, timing material placement in that location to coincide with a dormant period of the dominant species (October through April), would minimize potential impacts to this remaining bed. This bed may be the only root stock available adjacent to the project area and may be key to the recolonization of Poplar Harbor after construction. Precautions, therefore, will be taken to minimize construction impacts to the bed.

Longer-term impacts of material placement activities and turbidity due to barge positioning are not expected to impact the SAV resources because these activities will be conducted sufficiently far from the bed. The project will bury approximately 700 acres of shallow open water (<6 feet) that could potentially support SAV within the area of the proposed dike alignment. Current erosional patterns prevent this area from supporting SAV, and further loss of protective islands will rapidly decrease the potential habitat area. Portions of the shallow water areas associated with the Poplar Island archipelago that have historically supported SAV will be converted to an island/marsh complex. However, the restoration of Poplar Island will eliminate the wave action and turbidity currently associated with erosion of the existing land masses within the proposed dike alignment and will provide added protection to Jefferson Island and portions of Coaches Island outside the dike. This elimination/reduction of existing sources of suspended solids is expected to enhance the suitability of the area for future SAV growth. The dike will also afford greater protection to Poplar Harbor, which is expected to promote SAV recolonization due to lessening of wave action.

Once the dike is breached to allow tidal flushing of the completed marsh areas, resuspended material may migrate into Poplar Harbor. The material migration could potentially alter the particle size distribution of the harbor substrate. The effect of substrate alteration on future SAV occurrence or distribution is speculative, because future sediment composition cannot be predicted, and because recolonization will be dependent upon a variety of factors such as water quality, clarity, and the distribution potential of nearby seed stocks. It is anticipated, however, that finer sediments will predominate in the harbor. This will shift eventual SAV

dominance to plants typical of muddy substrates like those of salt marsh creeks/channels (e.g., redhead and widgeon grass). The salt marsh is expected to have a long-term positive effect on the existing SAV by moderating turbidity, nutrient fluxes, and phytoplankton blooms within Poplar Harbor.

5.4.7 Terrestrial Resources

5.4.7.a Vegetation Resources. The loss of vegetation on Poplar Island has been a historically occurring pattern over the past 150 years. Poplar Island has been reduced in size and cut into several islands, first fragmenting and then eliminating forested areas on the island. Three of the remnants now possess primarily tidal marsh areas that show continual signs of erosion of the marsh peat banks. South Poplar Island has been reduced to the point where it is frequently overwashed by tidal water and is being further reduced in size and elevation. In 1995, only marsh grasses remained on South Poplar Island with evidence suggesting that shrub growth has recently disappeared from the island.

Impacts to vegetation community resources will be minimal. The proposed alignment is far enough away from the four western remnants that little disturbance should occur during dike construction. Since the proposed alignment will not abut Coaches Island, vegetative communities on the island will not be disturbed by reconstruction. Further, dredged materials will be placed within the contained cells such that the remaining islands will not be buried. Vegetative communities remaining on the four western remnant islands will be preserved and used to seed and populate newly constructed areas surrounding the four remnant islands.

A major component of the proposed project will be the creation of tidal marsh and upland habitats that will restore the wildlife habitat of the Poplar Island area (Section 6.3). The dredged material placement and tidal marsh development are designed to result in minimal impacts to the existing tidal marsh on Coaches Island. The south side of Coaches Island will be protected by a sand dune, and a tidal gut will provide tidal water inflow to the remnants. The remainder of the dike alignment interface along Coaches Island will be constructed adjacent to unvegetated beach.

5.4.7.b Avifauna. Most bird species are characterized as terrestrial primarily because of their nesting habits. Species include waterfowl, wading birds, other colonial waterbirds, and shore birds. Many of these birds, however, rely upon aquatic habitats, including wetlands, beaches, intertidal areas, and transition zones between land and water to satisfy their life requirements.

Since the proposed dike construction and creation of a dredged material placement island may occur in phases, the associated impacts to avifauna will vary depending upon timing and location of construction activities. The basic impacts of construction to birds in the Poplar Island area will be disturbance of habitat. The 20 ft dike elevation will provide gradual slopes and should not be difficult for animals to traverse.

Where construction activities occur, the behavior of birds utilizing the area will be influenced by human activities, including equipment use, movement, and noise. This may likely displace birds utilizing discrete areas such as areas of shallow water habitat in the immediate vicinity

of dike segments. As the proposed construction sequence occurs, areas from north to south within the project area will experience disturbances. These are expected to be localized, and a certain amount of habituation to construction activities is likely. Habituation may also occur toward water-based transportation in and out of the project area through the established access channel. Disturbance of avian resources, including bald eagles (*Haliaeetus leucocephalus*) on Jefferson Island and colonial birds on Coaches Island, will be minimized by the distance between the dike alignment and these areas.

Although the remnant islands will remain intact, the area surrounding the remnants will be filled, reducing shoreline nesting habitat and shallow water foraging and resting areas. Birds utilizing these habitats will be forced to utilize other areas in the vicinity of Jefferson and Coaches Islands. They will also likely follow mobile forage fish and seek areas providing floating or submerged aquatic vegetation or accessible shellfish beds.

Colonial Waterbirds

Colonial waterbird colonies on Middle Poplar Island, including the large colony of double-crested cormorants and the smaller colonies of little blue heron (*Egretta caerulea*) and snowy egrets (*Egretta thula*), will be disturbed by construction activity in areas surrounding the island. It is assumed that an unquantifiable component of these colonies may move and seek other nesting colony locations in the area including Coaches Island or Jefferson Island during island construction. The USFWS recommends dredged material placement volumes per lift which do not inundate the cormorant rookery on Middle Poplar Island. If this is not possible, the Service recommends artificial nesting structures be erected adjacent to Middle Poplar Island prior to initial inflow to mitigate the loss. Double-crested cormorants are known to readily utilize artificial structures. In addition, the Service indicates that the colony could be impacted by construction activities occurring within 500 feet. The USFWS and DNR have requested that we take precautions to limit disturbance to the area within 500 feet from March 1 through July 15.

The colonial bird colonies on Coaches Island will likely remain unaffected by the proposed action. The periphery of the colony may be temporarily affected by human disturbances, including noise and general activity in the vicinity. The colony edge is approximately 500 feet from the proposed alignment, and the majority of the colony is insulated by its interior woodland location. The most distant point in the colony is approximately 1,500 feet from the proposed alignment. The USFWS has recommended time-of-year restrictions for construction of the containment berm and human activities along the entire forested portion of the southern shoreline, where that construction or human activity will occur within 660 feet. The time-of-year restriction for this portion of Coaches Island is recommended by the Service to be 15 February through 15 July, and will not be required for inflow operations.

It is anticipated that in the long term, the island to be created, which will have upland and lowland habitat, will ultimately favor colonization by a variety of colonial birds, including all of those currently using the area.

Gulls and Terns

The elimination of shallow water foraging and resting areas and the concentrated resting area afforded by the Middle Poplar Island barges will affect gulls. Gulls, particularly herring gulls (*Larus argentatus*), are very common in the region and have demonstrated adaptability to human presence. They will likely be able to adapt to other foraging areas and will quickly take to new structural features such as dikes or pilings.

Terns (*Sterna* spp.) will be affected by the proposed action because of the conversion of shallow water and open water foraging areas to the dredged material island. Those birds will be forced to seek foraging areas elsewhere and will follow the forage fish stocks.

There will be more potential nesting sites on the new island to support these birds. It is possible that there will eventually be good nesting habitat for the Least Tern, a Maryland protected species.

5.4.7.c Waterfowl. The most significant impacts to local native breeding waterfowl are likely those associated with American black duck (*Anas rubripes*) nesting. This species has suffered significant long-term population declines resulting from loss of habitat and from competition and hybridization with expanding breeding mallard populations. Nesting black ducks were observed in very low densities during the Poplar Island quarterly surveys (1.0 nesting hens per acre [EA 1995c,d]). It is anticipated, however, that creation of marsh and woodland cover as part of the restoration effort will benefit this species, at least locally.

Other potential impacts to waterfowl include the elimination of shallow water foraging and resting areas. This would primarily affect overwintering waterfowl, including sea ducks and diving ducks such as oldsquaw (*Clangula hyemalis*), scoters (*Melanitta* spp.), redhead (*Aythya americana*), canvasback (*Aythya valisneria*), scaup (*Aythya* spp.), and bufflehead (*Bucephala clangula*).

The sea ducks, particularly oldsquaw, are relatively common and abundant inhabitants of the Bay and should readily shift to other areas to forage. Once Poplar Harbor becomes better protected by the dike, and the SAV colonizes extensive areas, there would be a significant positive benefit to a wide variety of waterfowl species. Furthermore, the creation of tidal marsh interspersed with tidal creeks will create foraging areas and resting locations for waterfowl in the future.

Raptors and Scavenging Birds

The primary raptor affected by the proposed action is the osprey (*Pandion haliaetus*). Osprey nest and have been observed fledging young on all of the remnant islands with the exception of South Poplar Island. Following the recovery from effects of chlorinated pesticides, osprey populations have expanded dramatically in the Chesapeake Bay region. This species will opportunistically nest on a variety of elevated structures, including pilings, channel markers, building roofs, and piers. Artificial nesting platform structures can also be erected to facilitate osprey nesting. Overall, osprey populations in the area are not expected to be adversely impacted.

Another raptor in the study area vicinity, the bald eagle, has been observed only with the active nest site located on Jefferson Island. The potential effects of the proposed action on the bald eagle is further discussed in Section 5.4.8, "Rare, Threatened, and Endangered Species."

Shore Birds

Shore birds such as willet (*Catotrophorus semipalmatus*), dunlin (*Calidris alpina*) and semipalmated sandpiper (*Calidris pusilla*) may potentially be negatively affected by disturbance surrounding the remnant island habitats. Although the willet has been observed in breeding and nesting behavior on the four remnant islands, this species is not imperiled and is not listed as threatened or endangered by state or Federal agencies. Willets have also been observed nesting on Coaches Island. Other shore birds potentially affected by this proposed action may lose some minor forage areas such as beaches and intertidal zones along the remnant islands and along a portion of the beach where the proposed alignment will border Coaches Island. The tidal marsh nesting habitat for willet and other shore birds on Coaches Island is not expected to be adversely impacted.

The creation of a restored Poplar Island, including tidal marshes, tidal flats, and beach areas, will benefit nesting willets and other seasonal migratory shore birds by providing a much larger area for nesting and feeding.

5.4.7.d Mammals, Reptiles, and Amphibians. No significant impacts are likely to occur to reptiles, amphibians, or mammals due to the proposed action because no members of these groups were found on the four remnant islands during seasonal surveys (EA 1995a,b,c,d). However, diamondback terrapins (*Malaclemmys terrapin*) are known to utilize sandy tidal habitats for nesting. A short-term impact for this species includes the elimination of shoreline nesting habitat on the remnants. None of the terrestrial upland or wetland habitats where reptiles, amphibians, and mammals have been observed on Coaches Island will be destroyed by the proposed action. Coaches Island will likely act as a potential source of animals from which the new island can be colonized. In addition, the construction of a sand dune along the south shore of Coaches Island, which will leave a tidal gut open between the islands, will sustain suitable long-term nesting habitat for diamondback terrapins.

5.4.8 Rare, Threatened, and Endangered Species

No state or Federal threatened or endangered species are expected to be significantly impacted by the restoration of Poplar Island. The single nesting pair of bald eagles on Jefferson Island is not likely to be negatively impacted by the proposed action. Construction activities that occur on the northeastern side of the proposed dike alignment would be the most likely component of the project to affect bald eagles on Jefferson Island. These effects would be manifested by localized short-term disturbances during construction of the dike segment nearest to Jefferson Island. This segment is approximately one-quarter mile from the eagle's nest on the island which is the established restricted distance for the bald eagle's nest. Precautions would be taken during construction to avoid working within this area during the restricted periods. The proposed dike off-loading area is approximately 3,500 feet from the eagle's nest. These distances would be expected to provide sufficient buffer to prevent

abandonment of the nest. Still, a time-of-year restriction from 15 January through 15 June prohibiting construction and human activities within the quarter mile bald eagle protection zone surrounding the nest has been recommended by USFWS. If the eagles fail to nest or produce young, the recommended time-of-year restriction can be reconsidered.

The nest tree is in an area of the island where woodland cover has been greatly diminished by erosion and wave damage. This may soon eliminate the current nest's tree. The creation of the dike and northern cells for the restored Poplar Island will afford protection by reducing the rate of erosion of Jefferson Island, and will likely prolong the time the tree will remain in place.

The state endangered tern species identified in the project vicinity, Least Tern (*Sterna antillarum*) and gull-billed tern (*Gelochelidiron nilotica*), are not expected to be negatively impacted by the proposed action. Breeding colonies of these two species have not been identified in the project area; therefore, elimination of nesting areas is not assumed to be a consequence of project implementation. The effects that the proposed action will have on these two species relates to disturbance of forage activities during construction. Furthermore, the existing area of shallow water within the proposed dike alignment would be eliminated as a potential foraging area for these and other tern species under the proposed action. This reduction in foraging habitat will require terns to shift to other areas where forage fish congregate. In the larger (regional) context, the elimination of approximately 1,100 acres of open water habitat involves a less than 1 percent loss of the open water foraging habitat available in adjacent areas of the Chesapeake Bay. Further, enhancement of Poplar Harbor as a foraging area will afford good habitat; beach areas within the alignment along tidal channels may provide increased nesting habitat.

5.4.9 Air Quality

The reconstructed island will contain no fossil-fueled equipment or other sources of emissions. Construction and placement activities may cause some elevated emissions from boat activity and use of other gas-powered equipment. Some potential for suspension of particulates exists during filling/grading activities. As the dredged material dries and is subjected to wind, lighter materials may become airborne. These are expected to be short-lived events with no significant impact on air quality. Once the island is revegetated and the soils stabilize, the potential for airborne particulate will be minimized. Impacts to air quality from dike construction and material placement are, therefore, expected to be localized and short term. The project will have no long-term impacts on air quality.

5.4.10 Noise

Noise levels around Poplar Island will increase during construction of the dike, pumping of the dredged material to the diked area, and construction of the habitat areas. The potential effects of this noise on the heron rookery on Coaches Island and the bald eagle nest on Jefferson Island are discussed in Section 5.4.7. The seasonal human residents of Coaches Island and Jefferson Island will also experience some increase in noise levels, primarily during construction. The greatest noise effects will be experienced by the residents of Coaches Island during dredging and placement of the dike material and the dune wall adjacent

to the island. In the long term, after completion of the project, the area will return to noise levels natural to an uninhabited bay island.

The project area is approximately 1 to 1.5 miles offshore of the mainland. Experience from the HMI placement site indicates that the only noise disturbances that were considered noticeable were the back-up beepers on construction equipment and an inadequately muffled crew boat. Both were corrected or adjusted to acceptable levels. The major noise sources will occur during construction, with some intermittent sources during filling/placement operations. These sources will be from dredging operations, cranes, bulldozers, and crew boats. Only the crew boats will operate to and from Tilghman Island, Lowes Wharf or Kent Point (4 miles north). Noise levels (decibels) will be below 55 DbA at the mainland, the nearest sensitive receptor other than Jefferson and Coaches Island. Only sharp sounds of relatively high frequency such as back-up warning beepers are likely to be noticeable. These types of noises can be easily modified to below nuisance levels. Work boat noises are a common occurrence in Knapps Narrows and adjacent waters and would not be perceived as unusual.

Noises will be intermittent during filling/placement operations. Due to the distance between Poplar Island and the areas targeted for dredging (Baltimore Harbor Approach Channels).

Throughout the construction and filling operations, best management practices will be used to minimize noise emissions.

5.4.11 Hazardous, Toxic, and Radioactive Wastes

The proposed Poplar Island restoration project will not involve the use, storage, or transport of hazardous materials during or after construction. Neither the materials to be used in the construction of the dikes nor the dredged materials to be placed there are contaminated. The restored island will remain a wildlife sanctuary, and no other uses besides passive recreation will occur. Based upon these conditions, the construction and use of the area will not pose any significant environmental liability concern.

5.5 Impacts to Cultural and Archeological Resources

The Poplar Island Restoration Project, clearly a Federal undertaking, falls within the review requirements of the National Historic Preservation Act of 1966, as amended, and its implementing regulations 36 CFR, Part 800. These regulations require the agency to identify, evaluate, and mitigate impacts to National Register-eligible or listed cultural resources prior to project initiation. Further, these efforts are to be conducted in consultations with the appropriate State Historic Preservation Officer (SHPO) and, at times, the Advisory Council on Historic Preservation (ACHP).

As part of the prefeasibility study conducted by the state for the Poplar Island Project, an initial Phase 1A study was conducted in 1994. This study identified the potential for locating both significant prehistoric and historic sites and structures within the Poplar Island Complex. Following these investigations, it was recommended that further investigations be conducted.

Phase 1 terrestrial and marine surveys were conducted for the project in 1995. Prior to the initiation of the study, the study team consulted with the Maryland SHPO to design the investigative strategy. For terrestrial investigations, a standard testing program was designed in areas impacted by the project. For marine investigations, a combination of electronic survey techniques, mechanical sampling, and submarine survey were designed.

The Phase 1 investigations documented the presence of a single terrestrial site that would be impacted and six submarine anomalies. The terrestrial site, 18TA237, was rapidly eroding, and therefore, USACE recommended that Phase 2 investigations be conducted on an accelerated schedule. It was found that the historic remains did not retain sufficient integrity to qualify for listing on the National Register.

The marine investigations initially identified 27 magnetic anomalies, and recommended 6 sites for further investigations. In consultation with the Maryland SHPO, the USACE conducted these further investigations with a verbal acceptance of the results of Phase 1. The marine investigations documented that all six anomalies were either modern, natural, or too fragmented to qualify for National Register consideration.

The SHPO agreed with the results of the Phase 1 and 2 investigations that there were no significant cultural resources that would be affected by the Poplar Island project. Since the SHPO and USACE agree on the determination of no effect, no further work is necessary, and USACE has completed its responsibilities under NHPA. Formal concurrence from the SHPO is included in Annex C.

5.6 Impacts to Socioeconomic Resources

Impacts on the socioeconomic resources of the existing Poplar Island archipelago will depend, in part, on the scope of the project alignment and the timing of project construction. Impacts are also related to access, area closures, effects on income-producing aquatic organisms adjacent to the project, and public perception of the health and safety of harvestable resources within the affected environment.

Under the proposed project design, biologically productive areas of Chesapeake Bay waters within the dike alignment would be eliminated, adversely affecting some of the socioeconomic resources in the project area and region. The extent to which the conversion of these productive waters to marsh and upland habitats would impact socioeconomic resources is evaluated in the following sections.

The potential for employment of area residents is expected during dike construction, habitat development, and monitoring activities. Dike construction is projected to occur over a 2-year period. To meet such a deadline, support will be needed from the local workforce. Because some of the construction contractors may not be local residents, the potential for year-round utilization of local motels and restaurants also exists. Habitat development and monitoring will occur intermittently throughout the life of the project but will involve periods of intensive activity (ex. marsh planting) that may require support from the local workforce and area businesses.

The project will have no significant impact on minority or low-income populations in the project area. Members of the project team met with the Tidal Fish Commission to request that fishery areas that are currently closed be reopened. This action was requested to replace those areas lost to the project. The commission agreed to make recommendations to the DNR, with the caveat that watermen respect the marked boundaries.

5.6.1 Scope of the Project

The project construction schedule is an important consideration in determining socioeconomic impacts to the project area and the region. Barge traffic, dredging activities, and access operations would potentially impact the local residences on Jefferson and Coaches Islands, although these residences are used infrequently, predominantly during summer and hunting season. The associated commercial and recreational activities within and outside the proposed alignment would be affected by these activities as well. If construction occurs quickly and best management practices (i.e., stabilizing dredged materials quickly, limiting the area of access, quickly completing activities that cause disturbances, such as dredging) are utilized during construction, impacts to aquatic resources and, consequently, socioeconomic resources could be larger in scale but would last a significantly shorter period.

5.6.2 Economic Impact to Aquatic Resources

The current project alignment would impact approximately 1,110 acres of land and water currently within the 1847 island footprint. Upon completion, the project will shift 1,100 acres from shallow open water to salt marsh and upland habitats. Currently, this area contributes a portion of the total landings for finfish, shellfish, and blue crab fisheries in the Chesapeake Bay, which, in turn, contributes to the economic well-being of Talbot County and communities elsewhere. The economic value of aquatic resources obtained from within the waters surrounding the current archipelago are difficult to estimate because of the way that landings are tracked by DNR. Landings are reported as sales from specific sub-regions. The Poplar Island sub-region is considered to contain waters from the Bay Bridge to the mouth of the Choptank. Because of this, no attempt was made to obtain data for specific locations such as the Poplar Island archipelago. Moreover, impacts to nonharvestable life stages of aquatic resources that contribute to overall recruitment in a much larger area are difficult to assign a monetary value. Studies have been conducted to determine the monetary value of destroyed early life stages in association with power plant projects throughout the East Coast. However, these studies involve estimates of impingement and entrainment that can be more directly correlated. Losses from dredging and island creation activities have never been calculated nor correlated with impacts to sensitive life stages. Unlike power plant operations, dredging and construction activities can be controlled by timing construction to coincide with periods in which sensitive life stages are not present. In addition, the long-term habitat benefits are expected to translate to economic benefits.

Harvestable resources in the Chesapeake Bay region are reported on an annual basis to the DNR. Prices for harvestable resources fluctuate on a yearly and seasonal basis. Assigning a value to any one resource is difficult because of the many factors that play into the market price. Information on the monetary value of harvestable resources collected from the mid-Chesapeake Bay (Bay Bridge to mouth of the Choptank River) is discussed below. It should

be noted that past prices often have no correlation with future market prices for any harvestable resource. For these reasons, predicting the socioeconomic value of future harvestable resources in the archipelago region cannot be calculated with any precision and could be significantly different in any given year. However, qualitative analysis suggests that the net contribution of the Poplar Island area to fish and shellfish resources of the mid-Bay will be enhanced in the long term, after island restoration.

5.6.2.a Soft Clam Fishery. Over the last 5 years, soft clam prices per bushel have fluctuated widely. A 5-year (1989 to 1994) mean of \$55 per bushel for the region from the Bay Bridge to Cove Point was determined by the DNR (Table 3-22). A fluctuating soft clam population is partially responsible for the varying price levels. Soft clam populations fluctuate on a yearly basis, depending on reproductive success. In the region analyzed, soft clam catches have contributed significantly to the Maryland total in recent years. In 1993, over half of the Maryland total landings of soft clams came from this region. For reasons already indicated, it is difficult to determine what percentage of the soft clam harvest came from archipelago waters. Anecdotal information has indicated that in past years, a substantial harvest of soft clams has come from there. In recent years, a reduction in recruitment has limited the harvest Baywide, and current levels indicate it is unlikely soft clams are being harvested from archipelago waters. To offset potential economic impacts of reduced soft clam harvesting opportunities due to island reconstruction the Maryland DNR has agreed to open some previously closed beds for soft-clam harvesting. A minimum of 800 acres of Nelson Island Shoal in the Choptank River will be reopened for soft clam harvesting. Recruitment to harvestable size takes several years. If the completion of the project is protracted over many years, it is possible that a portion of the construction phase could coincide with an increase in the harvestable soft clam population in the area. Should both of these factors coincide, some socioeconomic impacts could occur. However, creation of wetland areas and increased SAV densities associated with the project could have positive long-term effects on the recruitment of future generations of soft clams by locally moderating available nutrients which may ultimately enhance production of bivalve food sources (plankton). This could enable local populations to recover quickly from any short-term impacts caused by construction/dredging activities.

5.6.2.b Oyster Fishery. Data from DNR indicated that the 5-year (1989 to 1994) mean price for oysters from the area (Region 027; Bay Bridge to the Choptank River) was \$20 per bushel. As previously discussed, it is not possible to determine which portion of this total catch came from the Poplar Island archipelago and its adjacent waters. However, the percentage of the total Maryland catch captured in the cited region over the last 5 years has been compiled and indicates only a small portion of the total state catch comes from this region. However, several oyster bars are known to exist adjacent to archipelago waters. NOB 10, located to the west of the islands, has two small viable beds resulting from recent seeding. NOB 11, adjacent to Coaches Island, is not currently believed to be productive. Any oysters collected from this region have constituted an insignificant portion of the state total. This would indicate that the current economic value of oysters in the region, and in the project area, is minimal. Construction of wetland areas associated with the project and reduction in turbidity from island erosion could, however, serve to enhance oyster recruitment and habitat in the archipelago region by providing areas in which recolonization could occur. Consequently, construction of the project could improve oyster bars in the area over the long

term. Any short-term impacts from construction would be expected to be minimal, but precautions would be taken to minimize impacts to the remnant oyster populations to ensure survival for future growth and expansion of the viable beds on the bar.

5.6.2.c Finfish Fishery. Landings and associated dollar value for several fish species have been compiled on a yearly basis by the DNR for Section 027 (surrounding Poplar Island) beginning in 1980 (Table 3-22). Menhaden were caught in the greatest quantity (1,167,146 pound average yearly catch between 1989 and 1993), and striped bass have been the most monetarily important species (\$463,639 in 1993). More recent data for striped bass was unavailable; however, an increase in both landings and dollar value would be expected because of the easing of restrictions associated with a 5-year moratorium that limited or completely restricted harvest of striped bass in an effort to replenish reproductive stocks. Other important commercial fish species caught within this region of the Chesapeake Bay include white perch, grey sea trout, herring, summer flounder, and bluefish. The total monetary contribution of each of these species, however, is significantly less than striped bass and menhaden. It is important to note that seasonal abundances and market conditions can affect the monetary value of any species on a seasonal or yearly basis.

Short-term impacts from project-related activities on local finfish landings may result due to localized effects on spawning and rearing habitat important during the early life stages of commercially important species. Impacts to these important lifestages can be minimized by timing those activities that cause disruption to habitat to coincide with time periods less critical for these lifestages. Moreover, once wetland habitats have been constructed, important nursery areas would be increased and could contribute to a higher recruitment of commercially important species. Further, the armor stone utilized in dike construction as well as rock piles may function as a reef structure for some juveniles and young. Harvestable resources would likely be impacted secondarily and only by a disruption in habitat utilization. It is difficult to determine direct impacts from a loss of habitat. Survey results of existing conditions indicated that fish utilization of the archipelago is greatest during the summer months (EA 1995d). Some impacts on harvestable fish could be minimized by timing major construction efforts to occur during periods of lower fish activity.

5.6.2.d Blue Crab Fishery. Blue crabs provide the most significant income-producing resource for most Chesapeake Bay regions. Landings and the monetary value associated with those landings exceed every other harvestable resource within Chesapeake Bay waters. In addition, total crab catches exceed catches of every other commercially important species combined (Table 3-22). In recent years, increasing pressure has been placed on the blue crab fishery as catches increase with the introduction of more efficient gear and an increasing demand. Stricter regulations on commercial and recreational crabbing have recently been instituted. For example, commercial crabbers must obey area closures and undetermined waiting periods for licenses. Recreational crabbers may only harvest on Fridays, Saturdays, and Sundays. In addition, the 1995 season will be closed early (15 November), compared to the normal season closing (31 December). As in most areas, the crab catch dominates the landings of commercially important species within Poplar Island archipelago waters. Observations made during the summer seasonal survey indicated that all portions of archipelago waters were actively fished for crabs by commercial watermen. Since archipelago waters are so shallow, this region is extensively fished during the summer

months. In addition, island waters likely provide habitats from which soft crabs can be collected, especially along shoreline areas, that provide protection from predators.

Impacts of the project on the socioeconomic resources associated with the crabbing industry would likely be related to the timing and scope of the project. However, regardless of the project configuration and timing, resources in terms of waters available to be fished would be lost. Due to the intensive nature of the fishery, it is possible that the individual watermen fishing these waters would experience temporary impacts, including reduction in catch and income, during the construction phase. In this region of the Bay, moving crab traps elsewhere is difficult without impacting commercial fisherman in other locations. Opening of additional clamming areas in the Choptank River as negotiated between MDNR and the Waterman's Association is expected to offset the potential economic impacts brought about by curtailed harvest of blue crabs and soft clams within the Project Area. This would allow some relief to individuals currently crabbing in the Poplar Island area. With the completion of the project, waters that once supported commercial and recreational crabbing will have been converted to marsh and upland habitat. The loss of these waters will be minimized by the increase in important nursery habitats in the region and in Poplar Harbor specifically. This increase in available habitat for nonharvestable lifestyles should eventually increase recruitment to harvestable lifestyles and enhance remaining waters within the region.

In summary, socioeconomic impacts resulting from the project are closely related to impacts on commercially important species that are harvested from the area. In general, some short-term impacts can be expected within the project area as a result of the project. Long-term adverse impacts are not anticipated and, in fact, some enhancement of resources could occur. A minimization of short-term impacts by timing disruptive activities to occur within periods of low utilization by commercially important species will be instituted during project construction. This action will limit disruption to the aquatic environment and to the local economy. If construction of the island is protracted over a longer period, impacts to resources could change, and a reevaluation of impacts may be necessary.

5.7 Impacts to Aesthetics and Recreational Resources

Negative impacts to aesthetics and recreational resources as a result of the Poplar Island project can be characterized as being short term in nature and primarily associated with the construction phase of the project. Upon completion of the project, both aesthetic values and recreational use is expected to increase in the area.

Short-term impacts to the aesthetic value of the island are related to construction and dredging activities. These include presence of construction equipment, exposure of unvegetated portions of the island, inaccessibility of the island area, and displacement of existing visual resources of the current island remnants.

Short-term impacts to recreational resources are related to a restriction of access that the project will require. During the construction phase, it is anticipated that the archipelago region will be closed because of dangers associated with construction activities. Moreover, the high level of activity in the area will likely reduce the existing recreational value in the

short term. Those activities that are enhanced by limited human disturbance (e.g., duck hunting, bird watching, and fishing) will be impacted during the construction phase.

5.7.1 Aesthetics

Creation of a large island within the middle Chesapeake Bay region will increase the aesthetic value of the area by restoring an historically significant feature to the current landscape/waterscape. More so than the existing archipelago, the reconstructed island will dramatically increase the visibility of the area to area users. The creation of a large Chesapeake Bay island will change the scenic vista within a relatively short distance, but will create very little visual impact from a distance of 1 mile or more. In addition, without reconstruction, the islands would continue to erode and would eventually disappear.

Once reconstructed, the island will provide an additional scenic backdrop to a region already considered to have a high aesthetic value. Construction activities would impact the area aesthetically.

5.7.2 Recreation

Recreational activities will be impacted in two ways during project construction. Some activities will have to be excluded from the region. These activities are primarily island-based activities and include bird watching, picnicking, and some recreational boating. Other activities may also have to be relocated away from the project area, including fishing, sightseeing, and hunting.

5.7.2.a Fishing. Within the current island configuration, fishing activities are concentrated in areas with an abundance of snag cover or areas with sharp drop-offs to deeper water. Impacts to recreational fishing are expected to occur during project construction due to limitations on access to current fishing areas. Many areas that are currently fished (e.g. snag field) will either be buried or otherwise inaccessible during island reconstruction, which will further limit this type of recreation within the immediate area.

Upon project completion fishing opportunities within and adjacent to the archipelago are expected to increase due to improvements to the adjacent shallow water habitats from saltmarsh and reef habitat creation and increased SAV densities. The containment dike will also provide some new structure within the region which may attract some sportfish species. The additional habitats are expected to enhance the recreational fishery in the long-term by improving the rearing and nursery areas, ultimately enhancing recruitment of popular sportfish species within and adjacent to the archipelago.

5.7.2.b Boating. Existing levels of boating within the current configuration of the Poplar Island archipelago is limited by shallow depths in the area. For that reason, impacts to recreational boating from the project are expected to be minimal. Creation of the island may increase recreational boating opportunities around the island by stabilizing erosion along the west side, making it safer for passage of deeper draft boats to cruise near the site. Access to the entire island will be restricted, however, to prevent disturbance to natural areas and bird populations.

Barge traffic will increase in the project area which may cause some disturbance to recreational boating. No information on barge traffic with respect to recreational boating is available from HMI. Most recreational activities in and around Poplar Island are related to sport fishing, much of which occurs in and around the existing snag fields in the vicinity of the island remnants. Reef structures (rock piles) are proposed for construction adjacent to the north corners of the dike to mitigate losses of these snag fields buried during construction. It is anticipated that much of the recreational boating in the immediate vicinity of Poplar Island will be diverted to the north end of the project area, away from the active barge traffic area. During dike construction, the proposed access channels and off loading areas will be in the south, and barge traffic is expected to pose minimal disturbance to or safety concerns for recreational fishermen. Barge channels and active approaches will be clearly marked and information will be provided to the Coast Guard regarding all activities. During island construction all recreational and commercial boating activities will be restricted within the project area which will further minimize safety concerns with respect to barge traffic. After construction of the dike, barge traffic is expected to be sporadic, occurring only when dredged material is transported to the site. Recreation and commercial traffic will also be restricted adjacent to the proposed island after construction which is expected to limit safety issues to the access channel area south of the project. Danger to recreational boaters in this area is expected to be minimal due to the sporadic barge schedule, public awareness of the project, marked channels and approaches, and the predominantly seasonal (recreational) boating use. To date, there have been no recreational boating accidents in the vicinity of HMI that can be attributed to barge/construction activity.

5.7.2.c Hunting. Impacts to hunting activities in response to construction activities are expected to be minimal. Currently only a low level of hunting activities occur within the archipelago region. Only those areas immediately offshore likely experience any significant hunting activity. Due to the abundance of suitable sea duck habitat in the region, it is expected that hunting activities that focus on the species will move elsewhere during project construction activities. Upon completion of the project, sea duck hunting could resume within close proximity of the reconfigured archipelago.

5.7.2.d Other Recreational Activities. Other recreational activities within the existing archipelago include bird watching and general sightseeing. Project construction activities would have a short-term impact on these activities, but time-of-year restrictions should avoid displacement of nesting waterbird colonies. However, if the no-action alternative were selected as the best course of action, the further erosion of the remnant islands would also cause the displacement of nesting colonies and waterfowl populations. It is expected that these species will take up residence in suitable habitats elsewhere in the mid-Bay region. Upon completion of the project, the creation of new habitat would increase the value of bird watching and sightseeing in the region.

It is also important to note that activities that occur on Jefferson and Coaches Islands would be only minimally impacted by island construction and could be expected to continue throughout the construction phase of the project. No significant long-term negative impacts are expected with respect to these two islands. Island reconstruction is expected to improve recreational activities on Coaches Island, and (to a lesser extent) Jefferson Island by protecting the remaining land masses from further erosion.

5.8 Environmental Benefits

5.8.1 Beneficial Use of Dredged Material

Clean dredged material is a potentially valuable natural resource with substantial benefits if properly used. Under existing USACE policy, dredging projects are to be conducted to maximize public benefits, and beneficial uses of the dredged material are an integral component of that policy (USACE 1992).

According to USACE, there are at least nine categories of potential beneficial uses for dredged material (1992). Five of these uses are applicable to the Poplar Island project:

- **Habitat restoration**—A key objective at Poplar Island is to employ dredged material to restore upland and wetland habitat lost to aggressive erosional forces over the last century.
- **Shoreline nourishment**—To support the habitat restoration and provide the foundation for emergent ecosystems, material dredged from the navigational channels will be emplaced and reinforced to provide an effective, long-term erosion barrier.
- **Recreation**—It is anticipated that Poplar Island, once restored, will again become a focal point for passive recreational activities in the central Bay.
- **Upland resource support**—A proportion of the area of Poplar Island will be restored to upland habitat. This component of the restoration will be crucial to wildlife, especially wading birds requiring woody vegetation for breeding rookeries.
- **Multipurpose land uses**—Restored areas of Poplar Island could accommodate and support recreational, educational, and research opportunities. If present erosional losses are allowed to continue, these use categories will vanish or be supported only by the existing open water habitat.

One key to beneficial use is timing. For the Poplar Island project, the navigational dredging and habitat restoration components of the program are both of great importance (also in keeping with Federal policy under the Water Resources Act of 1992). The need for placement of dredged material to restore the island ecosystems is imminent (because loss of the island remnants is proceeding), but not immediate. Coordination between these aspects of the program will maximize the value of this large-scale environmental restoration project.

Details of the cumulative beneficial effects of the use of dredged material for the Poplar Island Restoration Project are provided in Section 5.4.3. The overall beneficial use components of this navigational dredging project are summarized as follows: (1) Poplar Island was a valuable estuarine resource, now essentially lost to the Chesapeake Bay; (2) material dredged from navigational channels can be employed to restore Poplar Island; and (3) this restoration will provide substantial habitat and productivity to the Bay ecosystem,

Table 5-5: Projected Annual Dredged Material Quantities 1998-2018, Bay Channels; Baltimore Harbor and Channels Project, Maryland and Virginia.

Channel Section	Recent Annual O&M [Avg.]	Projected Annual O&M	Estimated New Work	Total 20-yr. Estimate
Virginia Channels				
Cape Henry Channel	236,300	250,000		5,000,000
York Spit Channel	45,900	50,000		1,000,000
Rappahannock Shoal Channel	0	5,000		100,000
Total Bay Dredging - VA	281,200	305,000		6,100,000
Southern Approach Channels				
Craighill Entrance Channel	166,300	200,000		4,000,000
Craighill Channel	38,900	50,000		1,000,000
Craighill Angle	475,000	500,000		10,000,000
Craighill Upper Range	47,700	60,000		1,200,000
Cutoff Angle	196,000	250,000		5,000,000
<i>Subtotal</i>	<i>923,900</i>	<i>1,060,000</i>		<i>21,200,000</i>
Northern Approach Channels				
Brewerton Extension	392,200	400,000	2,500,000	10,500,000
Tolchester Channel	213,500	250,000	3,000,000	8,000,000
Swan Point Channel	41,300	50,000		1,000,000
<i>Subtotal</i>	<i>646,000</i>	<i>700,000</i>	<i>5,500,000</i>	<i>19,500,000</i>
Total Bay Dredging - MD	1,569,900	1,760,000		40,700,000
Total Project Dredging - Bay	1,851,100	2,065,000		46,800,000

offering significant benefits to passive recreation, to commercial harvest of fish and shellfish, to education, and to research.

5.8.2 Attainment of Maintenance Dredging Needs

The Port of Baltimore is one of Maryland's most important economic assets. The port generates approximately 87,000 jobs, contributes nearly \$3 billion dollars in business, and represents one-tenth of Maryland's gross state product. The approach channels to the Port of Baltimore provide shipping access to and from the Ports of Norfolk, Philadelphia, New York, and the rest of the world. Maryland depends on regular depth maintenance and improvements to the channels of the upper Bay to maintain Port commerce. Table 5-5 presents the dredging needs for the central bay channels of the Baltimore Harbor and Channels Project for the next 20 years.

Immediate development of new placement options is imperative to keep up with future placement needs. Open water placement in deep areas of the Bay provides high volume placement at low cost, but does not provide a clear beneficial use of dredged material.

Development of small capacity beneficial use projects would solve the immediate placement problems, and meet beneficial-use goals of habitat creation, but would not fulfill the long-term placement needs of the Port of Baltimore and would be a more costly option.

The Poplar Island restoration project, due to its large capacity (38 million cubic yards), would provide placement capacity for clean dredged materials from the central Bay channels for approximately 24 years, longer than any other beneficial use projects currently under consideration. The project is designed to recreate highly productive habitat in the region while providing cost-effective attainment of maintenance dredging needs for the Port of Baltimore.

5.9 Irretrievable Uses of Resources

During island construction, some resources will be either expended in construction activities or impacted by those activities. If the resource is not renewable (e.g., something that reproduces), it may be irretrievable. Irretrievable resources come from both on-site and off-site sources. The most significant off-site resource will be the stone (gravel and armor) required for dike construction. This will be quarried from off-site locations and, once placed, will become a permanent component of the Bay bottom in that area. The sand required for dike construction will be borrowed from on-site locations, although it will no longer be available for alternate uses. Since open water sand mining has never been likely here, this use would be considered insignificant.

The most significant on-site irretrievable loss will be the covering over of approximately 1,100 acres of shallow water habitat and the burial of 27.2 acres of cover items (snag fields). These losses have been considered among the impacts of construction and will be offset, in the long term, by the increased productivity associated with functioning salt marshes, the addition of rock jetties, and the increased habitat value of SAV beds in Poplar Harbor. Although this is a reallocation of habitat, the long-term effects to aquatic resources are expected to be positive.

5.10 Environmental Justification

Traditional Corps projects for flood control, navigation, shoreline protection, and other purposes rely on a benefit-cost analysis to provide the best plan for project implementation. The difference between the monetary cost of the plan and the value of plan benefits describes the plan's net benefits. Typically, the plan that provides the greatest net benefits becomes the recommended plan.

Like the traditional projects described above, ecosystem restoration projects beneficially using dredged material must also be justified. The value of the ecological resources being protected, restored, or created must be established through legal or institutional recognition, scientific recognition, and public perception of value. Justification is typically demonstrated when the monetary and non-monetary outputs of the restoration project justify its incremental costs above the base plan. However, unlike traditional projects, there is no accepted method for quantifying environmental outputs in monetary terms. Because the benefits of restoration projects usually are not measured in currency, cost-effectiveness and incremental cost analyses are more appropriate benchmarks of a project's value. Though these analyses may not highlight the optimum solution, they will offer a tool for decision makers that is not totally divorced from cost considerations. Their results, displayed as graphs of outputs versus costs, allow a progressive comparison of alternative levels of environmental output.

Procedures for conducting cost-effectiveness and incremental analyses are based upon the conceptual framework of the U.S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*. While the *Principles and Guidelines* places emphasis on plans to achieve NED benefits, it also gives reference to allowing cost-effective plans to achieve other benefits, such as environmental benefits. The Corps' planning regulation 1105-2-100, *Guidance for Conducting Civil Works Planning Studies*, directed that incremental cost analyses be performed to discover and display variation in costs and to identify the least-cost plan. This direction was extended to the restoration of fish and wildlife habitat by Policy Guidance Letter #24. Engineering Circular 1105-2-210, *Ecosystem Restoration in the Civil Works Program*, further underscores the importance of cost effectiveness and incremental analysis.

Cost effectiveness and incremental cost analyses require three types of data: a list of solutions and, for each, estimates of the cost and the output. The plan formulation process should result in a range of independent and mutually exclusive plans. As discussed earlier, the formulation of plans for the restoration of Poplar Island was a true team effort involving not only the District's interdisciplinary team, but also representatives of resource agencies, the sponsor, and the public.

The initial assumption was that the project would consider restoration of Poplar Island to approximately its 1847 footprint. Several existing conditions were instrumental in arriving at potential project footprints: (1) poor foundation conditions to the north in the project area; (2) charted NOB to the west and east of the project area; (3) increased water depths to the south of the project area. These conditions yielded three potential project footprints: 820 acres, 1,100

acres, and 1,340 acres. In addition to protecting and enhancing remnant islands of the archipelago that have waterbird colonies, several environmental goals were identified for the restoration: (1) creating bare or sparsely vegetated islands as nesting habitat for colonial waterbirds such as terns, (2) creating vegetated islands for waterbirds such as egrets and herons, (3) creating tidal marsh to provide habitat for fish and wildlife and to provide food web support for the Chesapeake Bay ecosystem; (4) creating a diversity of habitats to benefit a wide range of fish and wildlife; (5) creating quiescent conditions for SAV recovery; and (6) minimizing loss of benthic habitat.

In addition to balancing the costs and benefits of habitat outputs, it was recognized that balance between upland habitat and wetland habitat was important. Three wetland-to-upland ratios were developed for each footprint: 100 percent wetlands, 70 percent wetlands, and 50 percent wetlands. Two upland elevations were also considered: +10 and +20. While trade-offs were being developed and discussed for the different footprints and layouts, project designers were developing the make-up of the habitat, based in part on the target species identified by the Working Group.

Much of the decision process was based on a desire to restore remote island habitat. Not only is this type of habitat scarce and significant, but so is the opportunity to restore and protect this type of habitat. At least thirteen remote islands have been lost in their entirety to erosion. Of the seven or so that remain, the two with the largest landmass (Bloodsworth Island and Smith Island) are predominantly marsh. The next largest is Hoopers Island which is the most developed of the group and could not be considered remote. The remaining islands comprise less than 500 acres, as surveyed in 1990, and probably are significantly smaller today. Opportunities for establishment of remote island habitat in the Bay are rare. The capability of the created upland to interact with the substantial adjacent wetlands acreage increases the value of this opportunity.

Recognizing this opportunity, and the regional benefit to balancing the upland and wetland habitat, it was determined that a more proportionate distribution of wetlands and uplands was desired. Evaluating the alternatives from a Chesapeake Bay ecosystem approach, a combination of 50 percent wetlands and 50 percent uplands would result in optimal environmental outputs, since for many waterbirds and most songbirds a greater percentage of uplands are required for nesting and other life requirements. This distribution would likely mirror the historic condition at Poplar Island. Currently Coaches Island is approximately two-thirds upland and one-third wetland. In addition to protecting and enhancing remnant islands of the archipelago that have waterbird colonies, this distribution would also promote four of the six environmental goals discussed earlier: (1) creating bare or sparsely vegetated islands as nesting habitat for colonial waterbirds such as terns, (2) creating vegetated islands for waterbirds such as egrets and herons, (3) creating a diversity of habitats to benefit a wide range of fish and wildlife; and (4) creating quiescent conditions for SAV recovery.

MPA has requested that upland elevations be constructed to +20 feet MLLW in order to provide more placement capacity for dredged material. The highest current elevation of Coaches Island is about +10 feet. While there is no increased habitat value on-site of the uplands at +20 feet

compared to uplands at +10 feet, the increased elevation allows for placement of millions of cubic yards of dredged material with almost no adverse impacts. This is a regional benefit because no additional shallow water habitat will be lost, whereas another placement site may require even more shallow water habitat to be converted to wetlands or uplands. Compared to construction of a new site at a similar distance from the project channels, where an armored facility will be required, raising the dikes is a less expensive alternative. In addition, should island restoration be the method of accounting for this additional dredged material, potential sites would be even further from the channels than Poplar Island.

The many discussions about the island size and configuration, and the proportions of wetland and upland habitats were resolved at a meeting at which resource experts from the Poplar Island Working Group met to offer their respective agencies' preferences for the site layout. Benefits, impacts, and trade-offs were argued, and a consensus was reached for restoring the island to 1,100 acres with 50 percent wetlands (80 percent of which is low marsh) and an upland elevation of +20.

IWR Report #95-R-1 describes this approach as "plans of others" and "ask an expert." In both approaches, the analysts are not directly concerned with how plans were formulated, but only in performing the cost analyses on the plans. In the first approach, plans are introduced from outside of the planning team; in this case, by the MPA. In the latter case, plan formulation utilizes the professional judgement and informed personal intuition of experts in appropriate disciplines, i.e., the Working Group. Plans chosen by either of these processes can be evaluated using the cost-effectiveness and incremental cost analyses procedures.

5.10.1 Relationships Among Management Measures

Once the site specifics were agreed upon, it was possible to evaluate the management measures required to develop the desired habitat. Management measures are the individual, separable actions that can be taken to affect environmental variables and produce environmental outputs. A management measure is typically made up of one or more features (structural elements) or activities (non-structural) at a particular site. They can be considered in different sizes, such as varying upland heights. The Poplar Island study team considered a number of variables including upland heights; the numbers and sizes of cells to be filled; numbers and sizes of wetland and upland ponds to be constructed; numbers, sizes, locations, and vegetative covers of nesting islands; and types of wetland drainage channels to construct.

In evaluating plans, it is important to understand the relationship of specific management measures to one another. Planning objectives can be used to identify management measures, and the resulting measures can then be used to develop alternative plans. Determining the configurations of management measures that can be combined into plans requires an understanding of the relationships between those measures.

It is important to have an understanding of which of the management measures under consideration can be combined with specific other measures. For a management measure, or

combination of measures to be considered a plan, it must be able to stand alone and must not be functionally dependent on the implementation of any other plan or measure. Dependency can be described as “mutually dependent,” where two or measures must be implemented in combination or not at all, or “path dependent,” where some measure(s) are dependent upon other measure(s), but the relationship is not reciprocal.

5.10.2 Cost and Output Estimation

When estimating the cost and output effects of solutions, all cost and output estimates need to be measured over the same period of time and in the same unit of measurement. Outputs and costs can be estimated either on an average annual output and cost basis, or on a total output and total cost basis, so long as the outputs and costs are comparable.

For ease of comparison, it is desirable that the environmental outputs of all alternatives be measured in like units (e.g., habitat units for a single species). While this operating assumption holds true for habitat created with a single species in mind, it may not be applicable when a more diversified habitat with several target species or habitat types is desired. Unfortunately, comparisons of different outputs (e.g., habitat units to acres) and habitat units for different species (e.g., American Black Duck and diamondback terrapin) are subjective and typically less meaningful than comparisons of like output units. At Poplar Island, this problem is magnified by the construction of different habitat types (upland and wetland) targeted to different species. It would be difficult, if not impossible, to select a single species to represent the diversity of outputs desired. As such, it was necessary to come to an agreement among the project team and Corps and resource agency experts as to acceptable formulas tailored to this specific project.

5.10.3 Site Specific Analysis

The alternative layouts included a variety of sizes and locations for the restored island. Table 5-6 summarizes alternative restoration configurations, types of habitat to be created, and the acres of each type of habitat produced by each alternative. Details regarding specific attributes for each habitat type (e.g., low marsh characteristics) and a comprehensive list of species expected to utilize each habitat type can be found in the Habitat Development Report. The interagency working group established a series of environmental restoration objectives. These objectives included (1) creating bare or sparsely vegetated islands as nesting habitat for colonial waterbirds such as terns, (2) creating vegetated islands for waterbirds such as egrets and herons, (3) creating tidal wetlands, (4) creating a diversity of habitats to attract and support a diversity of species, and (5) creating quiescent conditions for SAV growth. In addition, it was desired to protect existing valuable island habitat which is otherwise expected to be lost to erosion in about 35 years. The objectives summarized in Table 5-7 were developed to facilitate the selection of a final preferred project alternative. The alternatives were ranked by their environmental outputs, their capacities, and their costs. Methods of evaluating the alternatives are discussed in the following sections.

Table 5-6: Alternative project configurations and habitat created by each

Align- ment No.	Site area (acres)	Percent tidal wet- lands	Upland elevation (ft)	Low marsh (acres) (incl. open water within marsh)	High marsh (acres)	Upland forest (acres) (not incl. small islands)	Upland scrub/ shrub (acres) (not incl. small islands)	No. of bare sub- strate islands created	Bare sub- strate islands (acres)	No. of vegetat- ed islands added to existing islands	Vegetat- ed island area added to Poplar Island rem- nants (acres)	Finger groins (linear ft)	Open water area within tidal marsh (creeks, ponds, moats & entrance gut) (acres)
1	820	50	10	328	82	205	205	3	6	3	6	3000	21
1	820	70	10	459	115	123	123	3	6	3	6	3000	23
1	820	100		656	164	0	0	3	6	3	6	3000	24
3	1110	50	10	444	111	278	278	4	8	4	8	4000	28
3	1110	70	10	622	155	167	167	4	8	4	8	4000	30
3	1110	100		888	222	0	0	4	8	4	8	4000	33
2	1340	50	10	536	134	335	335	5	10	5	10	5000	35
2	1340	70	10	750	188	201	201	5	10	5	10	5000	38
2	1340	100		1072	268	0	0	5	10	5	10	5000	41
1	820	50	20	328	82	205	205	3	6	3	6	3000	21
1	820	70	20	459	115	123	123	3	6	3	6	3000	23
3	1110	50	20	444	111	278	278	4	8	4	8	4000	28
3	1110	70	20	622	155	167	167	4	8	4	8	4000	30
2	1340	50	20	536	134	335	335	5	10	5	10	5000	35
2	1340	70	20	750	188	201	201	5	10	5	10	5000	38

Table 5-7: Environmental Restoration Objectives and Measurement Parameters

Environmental Restoration Objectives	Measurement Parameter
Create bare/sparsely vegetated islands to provide nesting habitat for colonial waterbirds such as terns	Habitat Units produced for a representative species of this guild
Create/enhance vegetated islands to increase/provide nesting habitat for colonial waterbirds such as egrets and herons	Habitat Units produced for a representative species of this guild
Create tidal wetlands to provide habitat for fish and wildlife, and to provide food web support for Chesapeake Bay ecosystem	Habitat Units produced for community of fish and wildlife that utilize coastal wetlands, and total primary productivity output
Create a diversity of habitats to support a wide diversity of plant and animal species	An index of habitat diversity
Restore quiescent water habitat in Poplar Harbor to promote SAV recovery	All alternatives produce same output; no measure will serve to discriminate between alternatives

5.10.4 Project Alternatives Analysis Methods

Measures that can be used to quantify environmental outputs include analysis of impact to energy flow, populations, and habitat quality. Given the diverse objectives of the project, no single approach was deemed adequate for this purpose. Distinct evaluation criteria were selected for each environmental restoration objective to allow for an objective comparison of the benefits expected to be produced by each alternative.

Energy flow analyses are appropriate to evaluate objectives focused on ecosystem processes (e.g., the flow of energy through the food web). Energy flow analyses are based on the assumptions that the laws of thermodynamics hold for plants and animals, and that plants and animals can be arranged into feeding groups or trophic levels. An analysis of the net change in primary productivity that will result from the various alternatives is included, since analysis of the value of coastal wetlands is often linked to their production of organic matter. Energy flow analyses are appealing from a scientific standpoint, but knowledge of energy flow in ecosystems is fragmentary, and interpretation of data is often difficult. Population estimation techniques provide a direct appraisal of the impact of a project to animals (or plants). However, accurate estimates of existing populations of animals are difficult and may require several years of data to quantify the birth, death, immigration, and emigration rates that determine population growth. In addition, numbers of a particular species that a particular

habitat type can support (for example, how many striped bass 10 linear feet of a finger groin can support) are often unknown.

Habitat-based evaluation techniques offer a sound ecological basis for impact assessments without the constraints inherent in energy flow and population analyses. A variety of Habitat Evaluation Procedures (HEP) have been utilized to quantify and evaluate the environmental impacts produced by water resources projects. HEP can be either species or community focused. Species-oriented Habitat Suitability Index (HSI) models produced by the U.S. Fish and Wildlife Service were utilized in an effort to quantify the environmental outputs of this restoration for the waterbirds. For the restoration objectives that focused upon colonial waterbirds, a representative species from each guild was first selected for analysis. A guild is defined as a group of species that utilize a common habitat resource. A community-oriented model was utilized to quantify benefits produced by the coastal wetlands for fish and wildlife, since no species-specific model was considered adequate to represent the range of habitat needs of these species.

The HSI models utilize an equation to quantify habitat suitability for a particular species or community. Each equation incorporates a series of variables representing environmental attributes known to be critical for the success of a particular species or community.

The number of variables differs from model to model. It is often possible to eliminate many of the variables in the models and set them to constant values if the alternatives are equivalent with regard to these conditions. Each variable is used to determine a suitability index (SI) of the habitat for that variable. The value for each SI variable ranges from 0 to 1. Zero represents no habitat suitability; 1.0 represents optimum habitat suitability. Each SI value is determined independently. The model utilizes an equation incorporating the individual SI's to calculate a habitat suitability index (HSI) that ranges from 0 to 1. The HSI's are then used to calculate habitat units (HU's) for each alternative. HU's are defined as the area of a particular habitat type created multiplied by the HSI for that alternative. HU's are presented only to the nearest whole number, since acreage was generally determined only to an accuracy of the nearest acre.

Results from application of HEP for different species can not be added directly. One unit of habitat for one species does not equal one unit of habitat for another. Each model incorporates variables specific to the species focus of the model, and the models do not consider the same factors. In the case where different units of output are produced, the analysis may proceed either by creating an index that ranks the relative value of the habitats created (e.g., according to the relative scarcity/significance of the resource); or by considering each output separately. The diverse objectives of the project make independent consideration of each output important.

This project is considered to be a permanent feature; thus, the differences in development time for the component habitats and their respective environmental outputs are considered to be of minimal importance from a longer term (such as decades) perspective, although wetlands planting for some cells are planned to provide early environmental benefits. In order to fairly evaluate

the long-term benefits of the project, environmental outputs produced by each alternative are determined after habitat development is complete. It is estimated that this would occur sometime after year 55. By year 25, all the wetland and upland cells should be filled to design capacity with dredged material, and planted. Habitat development should be complete with regard to vegetation establishment within 30 years after all cells are filled and planted. However, full ecological functioning of the habitats will not begin for an undetermined period of time.

5.10.5 Discussion of Methods Utilized for each Environmental Objective

5.10.5.a Objective: Create nesting habitat for ground-nesting colonial waterbirds that nest on isolated bare or sparsely vegetated islands

This guild includes a variety of tern, gull, and skimmer species whose nests are very vulnerable to predators and human disturbance. Nesting success occurs when and where predator access and human disturbance are minimal. This guild has suffered a significant loss of nesting habitat on a regional scale due to loss of habitat to human development and activity, as well as to erosion. Foraging habitat is abundant, however. The project is expected to create both nesting and foraging habitat for this guild. Nesting habitat that will be created by the project is a highly significant contribution to the Chesapeake Bay ecosystem, whereas increased feeding habitat is not of great significance (although the close proximity of feeding habitat to breeding habitat is of importance). Therefore, only factors affecting site suitability for nesting are considered in this analysis. The Common Tern was selected to represent this guild since its habitat needs are representative of guild members, and this species is expected to nest on the non-vegetated islands created by the project. At this time an HSI model for the Common Tern is not available. However, an HSI model is available for the Least Tern. Nesting habitat needs of the Least Tern are very similar to those of the Common Tern, so the Least Tern model was utilized to quantify outputs produced by the project for this guild.

The Least Tern HSI model for nesting incorporates two variables focused on vegetative cover, but is valid only if foraging and substrate needs have also been met. It is expected that foraging habitat will be abundant. The substrate will be designed and placed to benefit this guild. The two variables incorporated in the model are (1) percent herbaceous and shrub canopy cover; and (2) average height of herbaceous and shrub canopy. Upland habitats with greater than 25 percent vegetative cover and or vegetation higher than 16 inches are modelled to have no value as nesting habitat. The only upland habitats of the restoration that are expected to be suitable as nesting habitat are the created bare/sparsely vegetated islands. The suitability index is 1.0 of an island habitat when cover and substrate conditions are optimized. All alternatives would incorporate similar substrate and vegetative cover on the created bare substrate islands to optimize utility of these features as nesting habitat for members of this guild, and all alternatives consider creating only 2-acre islands to minimize island attractiveness to predators. All other wetland and upland habitats, including remaining islands of the archipelago, will have greater than 25 percent vegetative cover, and are modelled to have no value as nesting habitat. Therefore, differences in habitat outputs for Common/Least Tern and other members of this guild for the alternative alignments are entirely a function of the total acreage of bare substrate islands created. Computations are included in Appendix B.

5.10.5.b Objective: Create nesting habitat for colonial waterbirds that nest on isolated vegetated islands

This guild includes a number of egret, heron, ibis, and cormorant species. Members of this guild nest on isolated estuarine islands, but also form colonies in other wetland and upland habitats on the mainland. These species' nests are vulnerable to human disturbance and also to predation, but to a lesser extent than the nests of the bare substrate nesting guild. The project is expected to create both nesting and foraging habitat for this guild. Nesting habitat that will be produced by the project is a highly significant contribution to the Chesapeake Bay ecosystem, whereas feeding habitat is not of great significance (although having feeding habitat in proximity to breeding habitat is of obvious importance). Therefore only factors affecting site suitability for breeding are considered in this analysis. The Great Egret was chosen to represent this guild since this species has a greater tendency to utilize isolated estuarine islands as nesting habitat in the Chesapeake Bay region than other members of the guild. Other species of this guild have needs less specific to the project output of isolated island habitat. The Great Egret HSI model developed by the USFWS was utilized to quantify outputs produced by the project for this guild.

The Great Egret HSI model for nesting on isolated islands includes only one variable: percent of island covered by woody vegetation greater than 3 feet in height. This SI is optimized (set to a value of 1.0) when greater than 60 percent of the island meets this criteria. All alternatives will maintain the existing vegetated islands and establish vegetation on the created islands to specifications that will be designed to benefit this guild. Therefore, differences in project output are entirely a function of the sum of vegetated island acreage created, maintained, and enhanced by the project. Habitat on Coaches, Jefferson, and the remnants of Poplar Island are included as project output since it is expected that habitat on these islands will only be maintained with a project, otherwise it is expected that this habitat will be lost to erosion within 35 years. However, application of this model requires an additional consideration. Larger islands are typically less valuable as colony sites than are smaller islands, due to the ability of larger islands to support resident populations of predators (such as fox and raccoon). To calculate effective acreage available for nesting, a correction factor was multiplied to the islands according to their size to compensate for increased predation on larger islands. Islands smaller than 50 acres in size are considered at full acreage value; on project completion, this category will include the enhanced remnants of Poplar Island and Jefferson Island. Islands greater than 50 but fewer than 250 acres in size are multiplied by a factor of 0.3; this category includes Coaches Island. Islands of greater than 250 acres in size are multiplied by a factor of 0.1; this category includes the contiguous area of upland created by the placement of dredged material. Computations are included in Appendix B.

5.10.5.c Objectives: Create coastal wetlands to provide fish and wildlife habitat, and to support the Chesapeake Bay food web

To quantify environmental outputs produced by the created marsh acreage for fish and wildlife, the community-based Wetland Value Assessment Methodology and Community Model for brackish marshes was utilized. This model was developed to evaluate wetland creation/restoration project proposals submitted for funding under the Coastal Wetlands Planning, Protection, and Restoration Act of 1990. These models represent the habitat needs of a variety

of species that utilize Gulf Coast tidal marshes at some time in their life history. Not all of these species occur in Chesapeake Bay marshes. Marshes along the mid-Atlantic coast possess a number of differences from tidal marshes of the Gulf Coast due to differences in climate and tidal regime, among other factors. However, the model does include variables for a number of the attributes that are important in determining the utility of the created marsh for fish and wildlife. Based on discussions with representatives from the USFWS, minor modifications were made to the model to improve its applicability to the Chesapeake Bay.

The model includes six suitability index (SI) variables. Four of these variables are ratios that are equivalent for all alternatives and are thus set as constants in the analysis. These constants are (1) percent open water covered by SAV, (2) marsh edge and open water interspersions, (3) salinity, and (4) aquatic organism access. Two model variables considered critical to the evaluation of habitat suitability do differ from alternative to alternative. These two variables are percent of marsh covered by emergent vegetation, and percent open water less than 3 feet deep.

Equations for the determination of SI_1 and SI_2 are presented below.

- $SI_1 = (0.009 \times \% \text{ marsh area covered by emergent vegetation})$
- The %project area covered by marsh in $SI_1 = (\text{marsh area created}) / (\text{marsh area} + \text{open water (e.g., tidal creeks, ponds, etc.)})$.

$$SI_2 = (0.007 \times \% \text{ area vegetated by SAV} + 0.3).$$

It is assumed that 10 percent of the adjacent shallow water areas will be occupied by SAV; thus, this SI variable becomes a constant equal to 0.37.

SI_3 values are determined graphically based upon a comparison of the proposed project to a pictorial series of marsh/open water interspersions configurations. The model favors marshes with creeks and ponds. An equal SI_3 value for all the alternatives was chosen since the alternatives do not differ notably in this regard.

The value for SI_4 was determined by calculating the area of open water less than or equal to 1.5 feet deep within the created marsh and comparing that to the total open water area to be created in the marsh.

The value for SI_5 is set to unity. The value for SI_6 for each alternative is set at 0.85 based upon the narrative description in the model. All alternatives are equivalent since aquatic organism access is determined by the gaps to be created in the protective dike.

The model equation incorporating the SI's discussed previously to calculate an HSI for each alternative is

$$HSI = [3.5 \times (SIV_1^3 \times SIV_2 \times SIV_6)^{1/5}] + [(SIV_3 + SIV_4 + SIV_5)/3]$$

Habitat on Coaches, Jefferson, and the remnants of Poplar Island are included as project output since it is expected that habitat on these islands will only be maintained with a project, otherwise it is expected that this habitat will be lost to erosion within 35 years.

To quantify and evaluate support to the food web that will be provided by the project alternatives, net primary productivity produced by each alternative was approximated. The habitat created by the project alternatives was considered in three rudimentary categories: wetlands; forested uplands; and open-water estuary. Primary productivity values were determined by acre for each habitat type based on values listed in Table 5.8. Computations of net gain in primary productivity are included in Appendix B.

Table 5-8: Ecosystem primary productivity values (Smith, 1980)

Ecosystem	Primary Productivity	
	(grams dry organic matter/m ² /yr)	(pounds dry organic matter /acre/yr)
Temperate deciduous forest	1,200	10,700
Wetlands	2,500	22,200
Estuary	1,800	16,000

5.10.5.d Objective: Restore quiescent water habitat in Poplar Harbor to promote SAV growth

While it is unclear to what degree Poplar Island Harbor will be colonized by SAV, members of the interagency working group believe that quiescent water conditions will promote substantial SAV bed development. In all, over 1,000 acres of SAV could be promoted by the quiescent area created in the lee of the restored island. All of the project alternatives considered will likely produce the same acreage of protected water habitat, and thus no means to discriminate between the alternatives based on this output is available.

5.10.5.e Objective: Create a diversity of habitats to support a wide diversity of plant and animal species

Habitat diversity was compared between the project alternatives using the Shannon-Weaver Index. This index is routinely applied to compare species diversity between habitats in ecological analyses. In applying the index to consider species diversity, numbers of individuals per species are tallied for each habitat being compared. One member of any species has the same relative value as one member of any other species, other factors not considered. This index weighs the contribution of each habitat type according to its relative abundance. In applying this index to this project to evaluate habitat diversity (rather than species diversity), it is assumed that an acre

of any habitat type represents a unit of that habitat type. Thus, 1 acre of salt marsh is equal to 1 acre of upland forest, other factors not considered.

The index is calculated according to the following equation:

- Diversity Index = $-\sum p_i(\log_{10} p_i)$, where P_i = (acres per particular habitat type)/(total restoration size in acres).

Higher values of the index indicate higher relative diversity. This index does not discriminate based upon total project size since the same diversity index will be calculated for an alternative with 2 acres of salt marsh and 2 acres of upland as for a site possessing 2,000 acres of salt marsh and 2,000 acres of upland.

The restoration alternatives would each have also incorporated creation of freshwater wetlands habitat within the uplands. However, details as to total area of this habitat type that would have been created for each alternative were not available.

5.10.6 Comparison of Environmental Outputs

5.10.6.a Objective: Create nesting habitat for ground-nesting colonial waterbirds that nest on isolated bare or sparsely vegetated islands

Given the simplistic model and optimum site conditions that will be produced by the created bare substrate islands, application of this model produced 1 nesting HU for Common/Least Tern per 1 acre of bare substrate island created (Table 5-9 and Appendix B). Configurations of the restoration with Alignment No. 2 produce the greatest number of nesting HU's for Common Tern (10 HU's), since this alignment is the largest and would contain the greatest number of bare substrate islands. Alternatives for alignment No.s 1 and 3 would both be expected to produce a notable positive impact to the member species in this guild, since suitable nesting habitat in the region will be substantially increased. Proposed acreage of bare substrate islands to be created was limited for all alternatives because of concerns over limitations in availability of sandy dredged material necessary to create these islands. If additional sand sources become available, then additional islands could be created.

5.10.6.b Objective: Create nesting habitat for colonial waterbirds that nest on isolated vegetated islands

Environmental output for this objective showed a wider range of nesting HU's produced than was determined for the previous guild represented by Common Tern (Table 5-9 and Appendix B). Nesting HU's were lowest for the alternatives that were 100 percent wetlands. Nesting HU's ranged from 31 to 35 HU's for these alternatives. Nesting HU's were highest on the alternatives which created and protected the largest areas of upland habitat; output from the 50% upland versions of Alignments 2 and 3 was 102 and 88 HU's respectively. The alternative configurations that would produce larger nesting HU's would be expected to provide a substantial positive benefit to populations of species within this guild.

5.10.6.c Objectives: Create coastal wetlands to provide fish and wildlife habitat and to support the Chesapeake Bay food web

The HSI's for the alternative configurations fell within a fairly tight range, which is not surprising since the alternatives presented are variations on the theme defined and are constrained within the plan formulation section of this report. Since $HU = HSI \times \text{marsh acreage}$, the values of HU's produced serve to discriminate between the restoration alternatives largely as a function of the total acreage of wetlands created. The alternatives with the greatest acreage of created wetlands produce the most habitat for the community of fish and wildlife species that utilize coastal wetlands (Table 5-9 and Appendix B). All the project alternatives represent a substantial increase in HU's for fish and wildlife species that utilize colonial wetlands.

Coastal wetlands are among the most productive ecosystems on earth. The primary productivity analysis shows that project alternatives that create higher acreages of wetlands will produce the greatest amount of organic matter to benefit the Chesapeake Bay ecosystem (Table 5-9 and Appendix B). All the alternatives would produce a significant increase in tidal wetlands on a regional scale. There are approximately 134,500 acres of coastal wetlands and approximately 1,600,000 acres of open water within the Chesapeake Bay watershed. The Alternative Alignments Nos. 1, 2, and 3 would cause the loss of 0.05, 0.08, or 0.07 percent of that habitat respectively - a negligible loss of open water habitat from a regional perspective. In exchange, the alternatives would create from 410 to 1340 acres of tidal marsh depending on the plan selected. This represents a regional increase of 0.3 to 1.0 percent of this habitat type - a far greater gain than the relative loss of open water habitat from a proportional perspective.

5.10.6.d Objective: Restore quiescent water habitat in Poplar Harbor to promote SAV growth

It is not possible to quantify benefits produced by the restoration in this regard because it is unclear to what degree Poplar Island Harbor will be colonized by SAV. Members of the interagency working group believe that the quiescent water habitat produced and maintained by the project will promote SAV bed development. In all, over 1,000 acres of SAV could be promoted by the quiescent area created in the lee of the restored island, but all of the project alternatives considered will likely produce the same acreage of protected water habitat, and thus no means to discriminate between the alternatives based on this output is available. SAV in Chesapeake Bay are widely regarded as keystone species of the shallow water ecosystem. SAV beds provide spawning, nursery, feeding, and refuge habitat for numerous species of waterfowl, finfish, and shellfish; absorb nutrients and oxygenate the water column; and reduce wave energy and promote settling of suspended solids (Funderburk, 1991). Development of SAV beds will enhance the ecological value of Poplar Harbor, and members of the interagency working group expect a resultant net gain in fish productivity over current conditions.

5.10.6.e Objectives: Create a diversity of habitats to support a wide diversity of plants and animals

Projects producing the highest ratio of uplands to wetlands among the alternatives produced the highest diversity indexes (Table 5-9 and Appendix B). The habitat diversity indexes for the alternatives ranged from a low of 0.330 to a high of 0.640. Species diversity generally increases as area increases; thus, it can be expected that the larger restoration alternatives will support a greater and more diverse number of species within each habitat type.

5.10.7 Economic Analysis Procedure

Modelled project habitat outputs were compared to total project costs in a cost effectiveness analysis to provide guidance for the selection of the best project alternative. The Corps of Engineers Cost Effectiveness Analysis for Environmental Planning manual (COE IWR Report 94-PS-2) was utilized for this evaluation. Table 5-9 displays the total costs and environmental outputs quantified in units specific to each objective as discussed in 5.10.2 (Cost and Output Estimation) for the various project alternatives.

For each objective, project alternatives were analyzed for economic efficiency by first reordering the alternatives so that they were listed in order of ascending outputs (Appendix B). For each level of output the least cost alternative was then identified, and alternatives which produced equivalent output at a greater cost were eliminated from further consideration. For each objective, project alternatives were then analyzed for economic effectiveness by conducting a pair-wise comparison of outputs and costs to identify and delete those alternatives that will produce less output at equal or greater cost than subsequently ranked alternatives. After the economic efficiency and effectiveness analyses were completed for each objective a number of cost effective solutions for each objective remained (asterisked in Table 5-9, also see Appendix B). After completion of a cost effectiveness analysis Corps' policy encourages conducting an incremental analysis (e.g., Evaluation of Environmental Investments Procedures Manual IWR Report #95-R1). However, too few cost effective solutions remained after the cost effectiveness analysis was completed to conduct a meaningful incremental analysis for the majority of the objectives. Given this situation no incremental analysis was performed.

5.10.8 Conclusion

The Poplar Island study team explored a variety of potential configurations for the restored island. In the interest of maximizing environmental benefits, several alignments and numerous interior arrangements were considered. Components considered for the development of the interior of the island included several ratios of wetlands to uplands, different percentages of low marsh in wetlands areas, different sizes and locations of ponds and islands, and a variety of vegetation types for both wetland and upland areas. Economic and environmental costs and benefits were weighed, explored by project partners and contractors, and discussed by the project team. Selection of the recommended alignment was based on extensive information-gathering and research.

Table: 5-9 Summary of 15 final project alternatives considered.

Environmental outputs are for year 55 after complete vegetation establishment in created habitats.

Configurations of Project Alternatives					Environmental Outputs								Costs and Capacity		
Alignment No.	Site Area (acres)	Percent Tidal Wetlands	Upland Elevation (ft)		Least Tern Nesting HU's	Great Egret Nesting HU's (1)	Coastal wetland HU's (1)	Net Gain in Primary Productivity (g/m2/yr)	Shannon Weaver Diversity Index for Created Habitats				Total Site Development Cost (\$ million)	Site capacity (mcy)	\$ Cost per cubic yard dredged material
				Objective: (2)	a	b	c	c	d						
No Action (3)	Undefined	0	0		0	0	0	-	-				0	0	0
1	820	50	10		6	72	*	335	41000	0.640	*		78	18.8	4.15
1	820	50	20		6	72		335	41000	0.640			88.6	28.7	3.09
1	820	70	10		6	55	*	461	254200	0.610	*		74.9	14.7	5.10
1	820	70	20		6	55		461	254200	0.610			81.6	20.6	3.96
1	820	100	-		6	*	31	*	574000	*	0.340	*	59.1	9.9	5.97
2	1340	50	10		10	102	*	531	67000	0.640	*		124.7	30.5	4.09
2	1340	50	20		10	102		531	67000	0.640			147.3	46.7	3.15
2	1340	70	10		10	75		736	415400	0.610			116.9	24.1	4.85
2	1340	70	20		10	75		736	415400	0.600			131	33.8	3.88
2	1340	100	-		10	*	35	1044	* 938000	*	0.340		89.4	16	5.59
3	1110	50	10		8	88	*	445	55500	0.640			104.7	24.5	4.27
3	1110	50	20		8	88		445	55500	0.640			122.1	37.9	3.22
3	1110	70	10		8	66		614	344100	0.610			100	20	5.00
3	1110	70	20		8	66		614	344100	0.610			110.8	28	3.96
3	1110	100	-		8	*	33	870	* 777000	*	0.330		76.3	13	5.87
(1) Includes existing islands of archipelago plus created habitat						(3) Assumes complete erosion of archipelago within 35 years									
(2) Environmental Restoration Objectives						*Indicates Cost Effective Solution									
a. Create bare/sparsely vegetated islands															
b. Create/enhance vegetated islands															
c. Create tidal wetlands															
d. Create a diversity of habitats															

When analyzing each alternative separately for cost-effectiveness based on the environmental objectives, there is no clear alternative that will maximize outputs. However, while not the most-cost-effective alternative in addressing any of the environmental goals, the outputs of the agency-supported alternative are comparatively well in every category, a sign that a well-rounded and diverse habitat plan has been developed. To maximize the outputs from the six environmental goals, and to provide the most cost-effective solution, and therefore to support the multi-objective ecosystem approach, it was determined that the agency-supported plan would be the optimal environmental restoration plan.